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Combination of Mesh Adaptivity with Fluid-Structure Interaction in EUROPLEXUS

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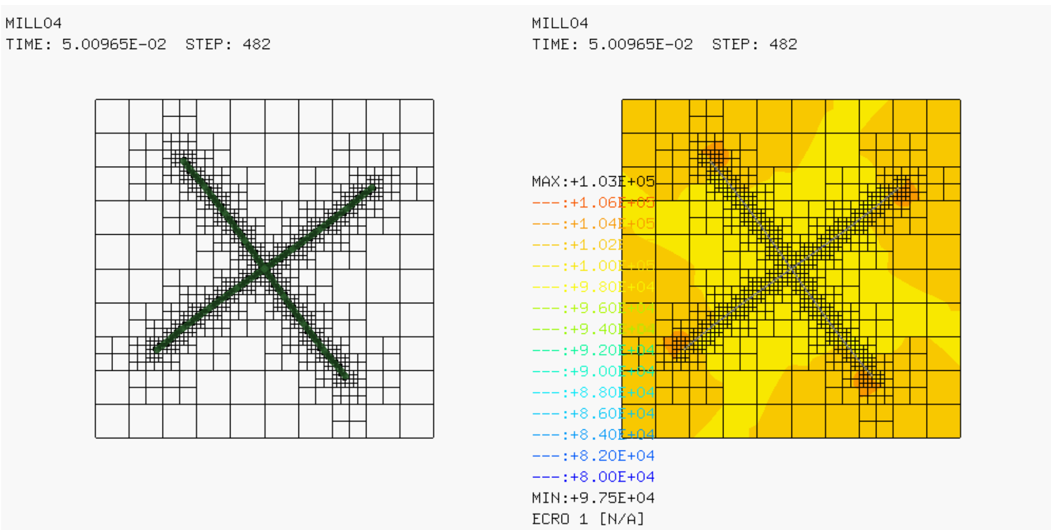

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1. Introduction

This report is a sequel to reports and publications [1-11] on mesh adaptivity in fast transient dynamics and presents the formulation and implementation of mesh adaptivity in combination with Fluid-Structure Interaction (FSI) algorithms in fast transient dynamics. The algorithms are implemented in the EUROPLEXUS code.

EUROPLEXUS [17] is a computer code for fast explicit transient dynamic analysis of fluid-structure systems jointly developed by the French Commissariat à l'Energie Atomique et aux Energies Alternatives (CEA Saclay) and by the Joint Research Centre of the European Commission (JRC Ispra).

Reference [1] presented the first implementation in EUROPLEXUS of an adaptive mesh refinement and un-refinement procedure, in two space dimensions (element shape QUA4) for solid mechanics. The procedure was extended to fluid mechanics (FE formulation) in 2D in reference [2]. Then, reference [3] applied a similar refinement and un-refinement procedure in three space dimensions to the CUB8 element shape, both in solids mechanics and in fluid mechanics (FE formulation).

All numerical examples presented in references [1-3] with a variable mesh used a so-called "manual" mesh adaptation directive, the `WAVE` directive (see the code manual in reference [17]), first introduced in reference [1]. This directive refines the mesh along "wavefronts" that are specified by the user, e.g. according to a known analytical solution to the problem considered. This technique was used with success to simulate a bar problem (in solid mechanics) and a shock tube problem (in fluid mechanics) both in 2D and in 3D [1-3].

However, those solutions cannot be qualified as "true" adaptive solutions, because in (true) adaptivity mesh refinement and un-refinement should be completely automatic, based upon suitable *error estimators* or *error indicators*. The formulation of error estimators in fast transient dynamics is challenging and is still a subject of research. The use of so-called error indicators, however, is much simpler. For this reason, subsequent work in EUROPLEXUS focused on error indicators. References [4] and [5] document a first prototype implementation of adaptivity based upon error indicators in EUROPLEXUS, limited to 2D problems in continuum and fluid mechanics. An extension of the indicator technique to 3D is under development but has not been completed and documented yet.

Publications [6-7] focus on the natural quantities of interest in goal-oriented error assessment and adaptivity, but limited to the case of linear elasto-dynamics.

The adaptive technique was then applied to Cell-Centred Finite Volumes (CCFV) for the description of the fluid domain, first in 2D (see [8]) and then also in 3D [9]. More recently, the technique has also been extended for use with the CDEM combustion model which makes use of the CCFV formulation [10]. A complete description of the element refinement and un-refinement techniques used in mesh adaptation has been published in a paper [11].

The present work concerns another aspect of mesh adaptivity, i.e. the automatic refinement of the fluid mesh near a structure, in order to enhance the treatment of Fluid-Structure Interaction (FSI). This technique is particularly useful in conjunction with FSI algorithms of the *embedded* or *immersed* type, such as the FLSR or FLSW algorithms available in EUROPLEXUS.

With these algorithms, the interacting fluid and structure are discretized in a completely independent way at the topological level. Typically, the fluid is represented by a uniform and regular (even structured) mesh fixed in space (Eulerian description) used as a “background” mesh. The structure is meshed independently and then it is “embedded” or “immersed” in the fluid mesh. The two meshes are therefore simply superposed.

A description of the FLSR and FLSW algorithms can be found in references [12-16].

Clearly, the precision of Fluid-Structure coupling depends very much on the use of a sufficiently fine fluid mesh, at least in the vicinity of the structure, and this is precisely the scope of adaptivity: to refine the fluid mesh only where it is needed, in this case close to the structure.

This document is organized as follows:

- Section 2 presents the formulation of FSI in conjunction with adaptivity, in particular the strategy for refining and unrefining the fluid mesh in the vicinity of the structure.
- Section 3 presents some numerical examples for the verification of the proposed algorithms, by using a FE discretization of the fluid domain.
- Section 4 presents the same examples but by using a CCFV discretization of the fluid domain.
- Some conclusions are given in Section 5.

The Appendix contains a listing of all the input files mentioned in the present report.

2. Formulation and implementation

In adaptive calculations with FSI, mesh refinement and un-refinement must occur also in the vicinity of a structure, in addition to the wavefronts which are tracked via `WAVE` or `INDI` directives.

Since this type of mesh adaptation is independent from `WAVE` or `INDI` directives, but is related to the chosen FSI model, it seems preferable to embed the corresponding input directive within the FSI directives (e.g. `FLSR` or `FLSW`).

In principle, the constraints on mesh size resulting from FSI should have to be merged with any constraints due to `WAVE`, `INDI` or any other (not yet developed) adaptivity directives. The *minimum* local mesh size resulting from all such constraints would then have to be retained. However, at the moment the implementation of `WAVE` and `INDI` are such that these models may not be combined in the same calculation. For simplicity, also the present adaptive FSI model is initially developed and tested as an independent model, incompatible with `WAVE` or `INDI`.

Once all these models are well tested separately, they will have to be re-implemented in a compatible way by developing a suitable combination strategy.

2.1 Syntax of FSI directives

The `FLSR`/`FLSW` directives have the following syntax:

```
$ FLSR ; FLSW $
         STRU /LECTS/
       $ FLUI /LECTF/ ; STFL $
     < $ R r ;       GAMM gamm ; PHIS phis $ >
     < $ HGRI hgri ; NMAX nmax ; DELE dele $ >
     < DGRI >
     < VOLU ; FACE >
     < BFLU bflu > < FSCP fscp >
     < ADAP LMAX lmax <SCAL scal> >
```

Note that the `VOLU` or `FACE` keywords are only available for `FLSW`.

The `ADAP` sub-directive is new and introduces adaptivity-related data for the concerned FSI model. At the moment, the only parameters that can be given are `LMAX`, the desired *maximum* fluid mesh refinement level near the structure, and `SCAL`, an optional scaling of the adapted zone (see Section 2.3.4).

2.2 Considerations on the maximum adaptive refinement level

In the `FLSR`/`FLSW` models for FSI, the structure is coupled with the fluid *entities* (usually nodes in the case of `FLSR`, cell interfaces in the case of `FLSW`) which are found to be currently located within the *structural influence domain*. This domain is formed by circles and quadrilaterals in 2D, by spheres, prisms and hexahedra in 3D. The circles or spheres are centered on the structural nodes while the other geometric shapes are built by connecting the circles or spheres.

Thus, the thickness of the influence domain at a structural node is the diameter of the associated circle or sphere. The domain thickness at a point of the structure not coinciding with a node is interpolated from the nodal values around it.

The user can specify the thickness in three alternative ways: by imposing a uniform sphere radius R via the keyword `R`, or by imposing a variable sphere radius via the keywords `GAMM` (which is related to the local *fluid* mesh size) or `PHIS` (which is related to the local *structure* mesh size). In any case, a sphere radius R is finally associated with each structural node, so that the local thickness of the influence domain is $D = 2R$.

In order to ensure *tightness*, i.e. to avoid spurious fluid passage across a solid structure, the local thickness of the structure influence domain (i.e. the sphere diameter $D = 2R$) must be greater than the diagonal of the local fluid mesh cell, see Figure 1. If the fluid mesh is formed by squares in 2D or cubes in 3D, of size h, then in order to ensure tightness it must be

$$D > \sqrt{d}\ h \tag{1}$$

where d is the space dimension (2 or 3).

This condition ensures (at least in the case of a Finite Element formulation for the fluid) that a continuous layer of fluid entities is coupled with the structure, even in the worst possible case that the structure is located exactly in the middle between two fluid entities, and has an oblique direction (not aligned with the global axes).

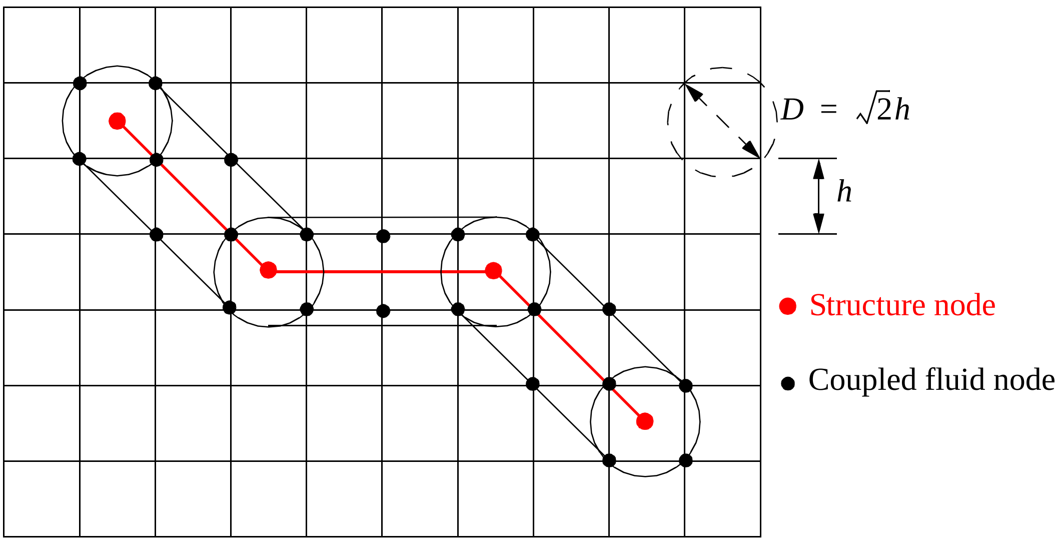


Figure 1 - Structure influence domain for tightness

Using a value of D much larger than the one given by eq. (1) is not advisable, because too much fluid would be “attached” to the structure. In each practical situation, the minimum value ensuring tightness is the best one.

When mesh adaptivity is adopted in the fluid domain, the size of the fluid mesh varies according to the level of refinement. A *binary* rule is adopted, whereby the size of each level is half that of the previous level. By convention, the *base* (ancestor or unrefined) fluid elements are placed at level 1. Let us therefore denote h_1 the size of the base fluid mesh. At any other level of refinement $L > 1$, the size of the fluid mesh will be

$$h_L = \frac{h_1}{2^{L-1}} \tag{2}$$

i.e. 1/2, 1/4, 1/8 etc. of the base size.

The practical convention is adopted that the user always specifies the `FLSR`/`FLSW` data *referred to the base fluid mesh*, also in the case of an adaptive calculation. Then, if adaptive FSI is desired, the `ADAP` keyword is added to `FLSR`/`FLSW` and the `LMAX` keyword is used to introduce the desired maximum refinement level (`lmax`) of the fluid mesh near the structure. In this way, various levels of refinement can be tried out by changing only the `lmax` value.

2.3 Adapting the fluid mesh

To obtain a progressively refined fluid mesh near the (moving) structure, from level 1 (base mesh) to level $L_{\max}$ (the chosen maximum), we proceed as illustrated in Figure 2 where just one structural element is considered for simplicity. Each used fluid element (base or descendent element, in adaptivity) is uniquely identified by the position of its *centroid*, i.e. the average position of its nodes.

Then, a hierarchy of $L_{\max}$ structural influence domains, similar to the one used to detect FSI, are built in order to adapt the mesh. Each influence domain is similar to, but has half the thickness as, the previous one in the hierarchy.

The first (coarsest) influence domain (for $L = 1$) coincides exactly with the influence domain that would be used by `FLSR`/`FLSW` in the absence of adaptivity, i.e. it has the thickness D_1 declared in the input data set. For example, if a uniform sphere radius R_1 has been specified via the R keyword, then $D_1 = 2R_1$.

The last (finest) influence domain (for $L = L_{\max}$) has thickness $D_{L_{\max}} = D_1/2^{L_{\max}-1}$. This last domain is the one automatically used to detect FSI. Therefore, when `ADAP LMAX` is specified the radius actually used for FSI is not R_1, but $R_{L_{\max}} = R_1/2^{L_{\max}-1}$.

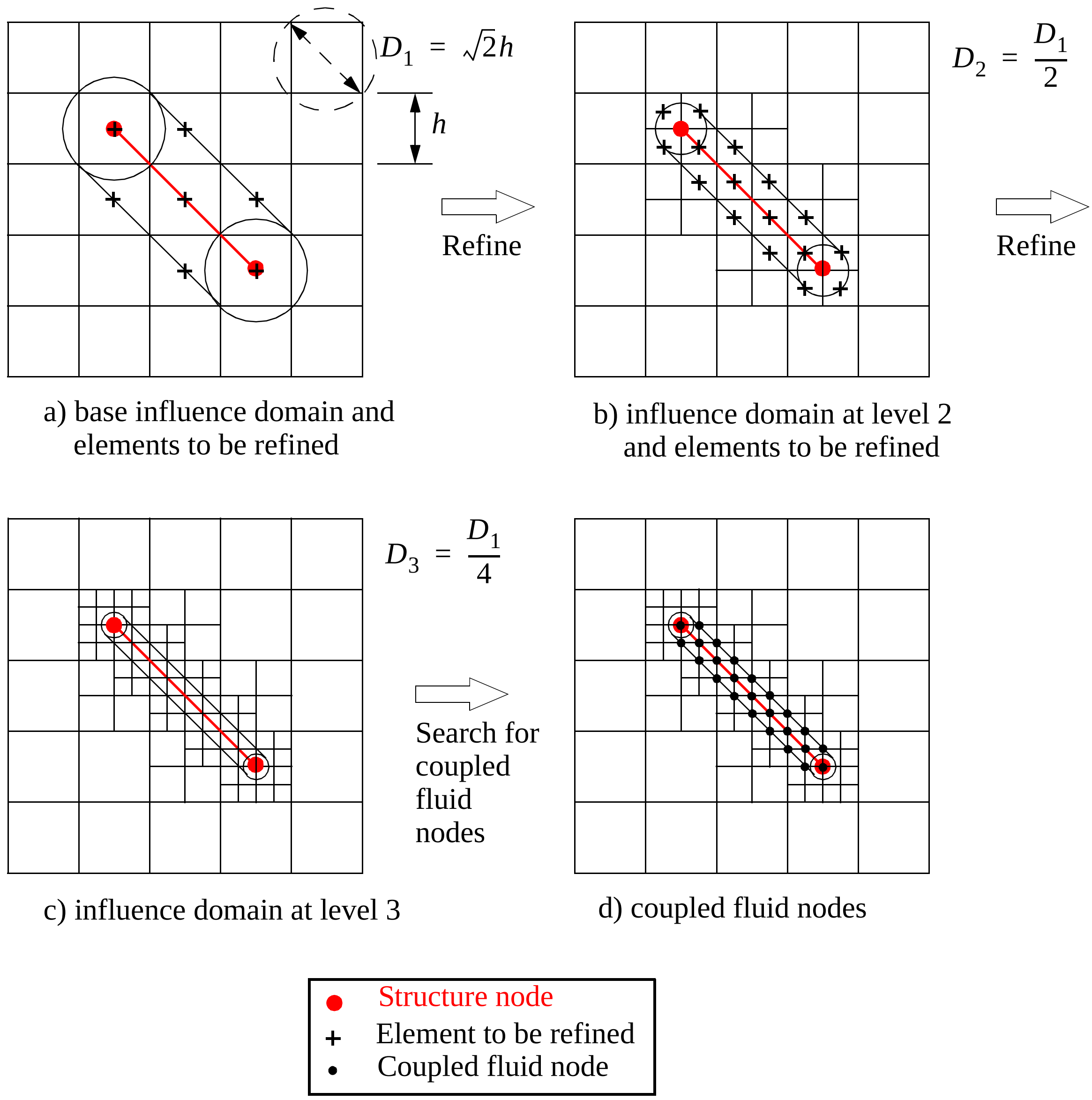


Figure 2 - Progressive scaling of structural influence domain to pilot fluid mesh adaptation

In the simple illustrative example of Figure 2 we consider refinement up to level 3, i.e. `ADAP LMAX 3`. We assume that the user has declared in the input file an influence domain radius $R = \sqrt{2}h/2$ (or slightly larger), with h the size, assumed here uniform for simplicity, of the *base* fluid mesh. We indicate with $D_1 = 2R = \sqrt{2}h$ the diameter ("thickness") of the base influence domain. This is used to find the base fluid elements that need to be refined, as shown in a). These are all the fluid elements whose centroid falls within the influence domain, and are indicated by a cross. In b) we can see the fluid mesh refined to level 2. Then a scaled-down structure influence domain of thickness $D_2 = D_1/2$ is used to identify the fluid elements which need to be further refined. In c) we can see the refined fluid mesh at level 3, which is the final one in this case. In this example the option `OPTI ADAP RCON` (see Section 2.3.3) is not activated, for simplicity, so in the resulting mesh there remain some element size transitions that stay in a ratio greater than two. Finally, the code uses the *finest* influence domain $D_3 = D_1/4$ to locate the *fluid entities* which have to coupled with the structure, as shown in d). In this example, these entities are simply the fluid *nodes* (as is typical with the `FLSR` algorithm). In case of `FLSW`, these could also be the *cell interfaces*.

The complete refinement and un-refinement procedure is as follows.

Two loops are performed at the beginning of each time step to adapt the fluid mesh. In the first loop, “coarse” fluid elements which now find themselves “near” the structure are (progressively) *refined*, while in the second loop “fine” fluid elements which now find themselves “far” from the structure are (progressively) *unrefined*.

Each loop proceeds by examining *one level at a time*. The refinement loop does this in *increasing* level order (from level 1 to level $L_{max} - 1$), while the unrefinement loop does this in *decreasing* level order, from level $L_{max} - 1$ to level 1). Note that elements in level L_{max} are never examined directly. In fact, they need no refinement since they are already at the maximum refinement level. Neither are they (directly) examined during unrefinement, because the unrefinement process is nominally applied to the parent element and not to its children.

2.3.1 Mesh refinement loop

The following <u>refinement criterion</u> is adopted. An *active* element at level L is refined (once) if its centroid lies inside the structure influence domain of level L. Active elements in adaptivity are those which are currently used but have no children, i.e. they are *leaves* in the elements tree.

Therefore, starting at level 1, all active elements at level 1 (i.e. all active base elements) whose centroid lies within the basic structure influence domain (of thickness D_1) are refined. to level 2. Next, we examine active elements at level 2. If such an element lies in the domain of thickness $D_2 = D_1/2$, then it is refined to level 3. And so on, until we examine elements in level $L_{max} - 1$. The proposed algorithm is as follows.

Algorithm R (refinement)

1. Set level $L = 0$.
2. Increment level: $L = L + 1$.
3. Loop over the elements i.
4. If element i is unused, cycle.
5. If element i has a level $L_i \neq L$, cycle.
6. If element i is inactive, i.e. if it has children, cycle.
7. If the centroid of element i is *not* contained inside the structural influence domain of level L, characterized by thickness $D_L = D_1/2^{L-1}$, cycle. This check is done by a fast search procedure

considering all the structural sub-domains contained (i.e. whose centroid lies) either within the same spatial cell as element i, or in a direct neighbor cell.

8. Refine element i.
9. End loop over the elements.
10. If $L < L^{\max} - 1$, GO TO 2.
11. End of refinement.

In order to avoid *ping-pong* effects, the successive unrefinement algorithm should not undo what the refinement algorithm has just done.

2.3.2 Mesh unrefinement loop

The following unrefinement criterion is adopted. An *inactive* element at level L is unrefined (once) if its *children* are all *active* (i.e. they have no children of their own) and if its centroid does *not* lie inside the structure influence domain of level L.

Therefore, starting at level $L_{\max} - 1$, all inactive elements at this level whose centroid does not lie within the influence domain ($D_{L_{\max} - 1}$) are unrefined once to level $L_{\max} - 2$, and in doing so they become active while their children become unused. At this particular level there would be no need to check that the children are active, since they are at the maximum level $L_{\max}$. Next, we examine inactive elements at level $L_{\max} - 2$. If such an element has all active children and lies within the influence domain ($D_{L_{\max} - 2}$), then it is unrefined to level $L_{\max} - 3$. And so on, until we examine elements at level 1. The proposed algorithm is as follows.

Algorithm U (unrefinement)

1. Set level $L = L_{\max}$.
2. Decrement level: $L = L - 1$.
3. Loop over the elements i.
4. If element i is unused, cycle.
5. If element i has a level $L_i \neq L$, cycle.
6. If element i is active, i.e. if it has no children, cycle.
7. If any of the children of element i is inactive, i.e. if it has its own children, cycle.
8. If the centroid of element i is contained inside the structural influence domain of level L, characterized by thickness $D_L = D_1 / 2^{L-1}$, cycle. This check is done by a fast search procedure considering all the structural sub-domains contained (i.e. whose centroid lies) either within the same spatial cell as element i, or in a direct neighbor cell.

9. Unrefine element i.

10. End loop over the elements.

11. If $L > 1$, GO TO 2.

12. End of refinement.

2.3.3 About the ADAP RCON option

Note that in order to ensure correct functioning of the refinement and unrefinement loops, elements should be refined or unrefined just by one level at a time and *this must in principle have no effect on the neighboring elements*. In other words, the option ADAP RCON should in principle be disabled for prudence.

This option is sometimes used with the other adaptivity algorithms (WAVE or INDI) in order to ensure smooth mesh transition. In the case of adaptive FSI, however, the mesh transition is completely controlled by the refinement and unrefinement algorithms described above. The use of ADAP RCON is therefore, at least in principle, incompatible with adaptive FSI and could possibly lead to ping-pong effects (i.e. immediate un-refinement of elements which have been just refined at the same step of the time loop), and thus to bad results.

However, preliminary tests by adding a check of ping-pong operations (which has a certain cost, however) seem to indicate that in practice, at least in the first tests performed, no ping-pong occurs. Therefore, the code does not stop if the ADAP RCON option is used in conjunction with FSI.

2.3.4 Optional scaling of the refined zone

In alternative (or in addition) to the ADAP RCON option described in the previous Section, users may want to impose a scaling factor s to the refined zone. This can be done by specifying ADAP LMAX lmax SCAL scal in the FLSR or FLSW input directives. By default, $s = 1$.

The scaling factor s applies to all influence domains used for the mesh adaptivity process, from level 1 to level L_{max}. However, the factor does *not* apply to the search of the fluid entities in interaction with the structure.

For example, by specifying $s = 2$ one would obtain a twice thicker refined fluid mesh zone around the structure, at each level of refinement. This is likely to produce a smooth mesh size transition *even without* specifying the ADAP RCON option. However, changing s has no influence on the thickness used to detect the fluid entities (nodes or interfaces) and thus the number of interacting fluid nodes or interfaces does not depend upon s.

3. Numerical examples with FE

We present some numerical examples in order to test the algorithms described in the previous Section. We start by considering FE discretizations of the fluid domain. In the next Section the same tests will then be repeated by using CCFV discretizations of the fluid domain.

3.1 Flying plate in 2D

The first example is that of a metallic plate flying at a certain initial velocity within a square domain containing a compressible fluid, see Figure 3. The fluid domain (perfect gas material) has a dimension of 10×10 m and its walls are rigid (but the fluid can slide along the walls without any resistance). The plate, made of steel-like elasto-plastic material, is located at 1.5 units from the left wall of the fluid domain, has a length of 7 m and an initial velocity of 100 m/s. In all cases, the plate is modelled by just 7 shell elements of type ED01.

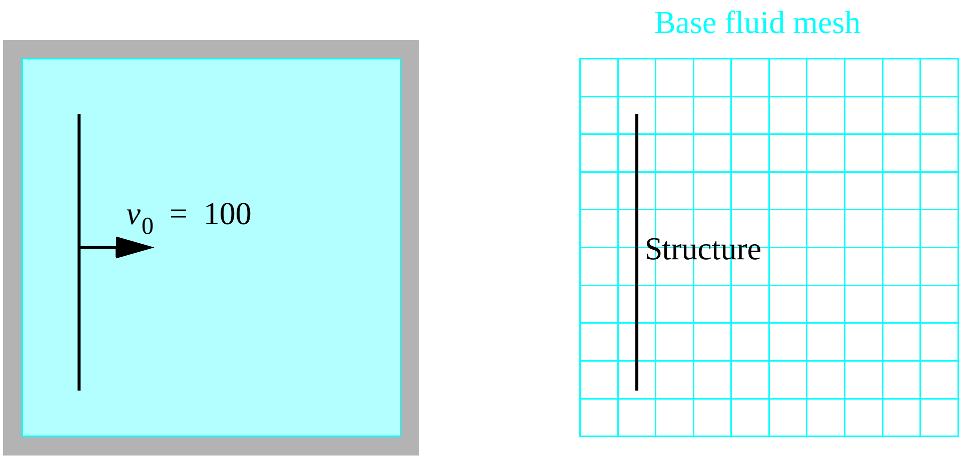


Figure 3 - Definition and initial mesh of the flying plate problem

First, a reference solution is obtained by means of non-adaptive calculations with more and more refined fluid meshes. Then, adaptive calculations are tested. All performed calculations are summarized in Table 1.

Case	Fluid Mesh	Notes	Steps	CPU [s]	Els*step
FSIA11	100 FL24	No adaptivity	961	0.7	102,934
FSIA12	400 FL24	No adaptivity	961	1.0	391,534
FSIA13	1,600 FL24	No adaptivity	961	2.8	1,545,934
FSIA14	6,400 FL24	No adaptivity	1,180	12.4	7,566,667
FSIA06	base: 100 FL24	ADAP LMAX 3, RCON	961	1.7	223,156
FSIA09	base: 100 FL24	ADAP LMAX 4, RCON	1,123	2.8	457,906

Table 1 - Calculations for the FSIA problem with FE in the fluid domain

Case	Fluid Mesh	Notes	Steps	CPU [s]	Els*step
FSIA10	base: 100 FL24	ADAP LMAX 4 SCAL 2	1,132	3.3	650,677

Table 1 - Calculations for the FSIA problem with FE in the fluid domain

3.1.1 Solutions without mesh adaptivity

FSIA11

This test uses a very coarse fluid mesh, of just 10×10 FL24 quadrilateral fluid elements. The initial FLSR structural domains and coupled fluid nodes are shown in the first part of Figure 4. Then are shown the same quantities, the pressure field and the velocity field at 50 ms (half of the transient calculation) when the fluid flow is already well-developed.

FSIA12

This test is similar to the previous one but uses a more refined fluid mesh, of 20×20 FL24 quadrilaterals. Some results of this test are shown in Figure 5.

FSIA13

This test is similar to the previous one but uses a more refined fluid mesh, of 40×40 FL24 quadrilaterals. Some results of this test are shown in Figure 6.

FSIA14

This test is similar to the previous one but uses a more refined fluid mesh, of 80×80 FL24 quadrilaterals. Some results of this test are shown in Figure 7.

Figure 8 compares results of all four calculations, showing the displacement and velocity of a node near the center of the plate. It can be seen that, apart the coarsest-mesh case (FSIA11), the solution is only slightly sensitive to fluid mesh fineness, if one considers only the plate motion. We will assume as reference the solution with the finest mesh (FSIA14), i.e. the green curves in Figure 8.

3.1.2 Solutions with mesh adaptivity

FSIA06

This test uses a base fluid mesh of 10×10 FL24 quadrilateral fluid elements, exactly like in case FSIA11. However, in the FLSR directive we specify `ADAP LMAX 3`, i.e. adaptive refinement near the structure up to a level 3 (thus a refinement of up to a factor 4 with respect to the base mesh), which would correspond to a fluid mesh of the same size locally as case FSIA13. Some results of this test are shown in Figure 9.

In this case use has been made of the `OPTI ADAP RCON` option in order to keep the adapted mesh always graded. Without this option, the jump in mesh size between two neighboring fluid elements was more than 2, in some cases. Despite use of the option, no ping-pong effects were detected by the dedicated check.

The solution is similar to the one of case FSIA13, although the base mesh is the one with only 10×10 elements, which is too coarse (since in the preliminary study the solution with this mesh was quite bad). Probably, a better choice would be that of using at least a 20×20 base mesh (like in case FSIA12). This would substantially improve the result in the non-refined zones of the mesh with only a very marginal increase of the CPU time.

Note that in this calculation the user specifies the FLSR directive e*xactly like in the case without adaptivity* (apart from the additional `ADAP LMAX` keyword). In other words, we use an FLSR radius $R = 0.7072$ (for a square base mesh of size 1.0), the same as in case FSIA11, while in the case FSIA13 (without adaptivity) we had to specify $R = 0.1768$, i.e $1/4$ of the previous value.

FSIA09

This test is similar to FSIA06 but in the FLSR directive we specify `ADAP LMAX 4`, i.e. adaptive refinement near the structure up to a level 4 (thus a refinement of up to a factor 8 with respect to the base mesh), which would correspond to a fluid mesh of the same size as case FSIA14. Some results of this test are shown in Figure 10.

Again, we specify an FLSR radius $R = 0.7072$ (for a square base mesh of size 1.0), the same as in case FSIA11, because this is the value related to the *base* fluid mesh.

This solution is very similar to FSIA06, the main difference being due to the better resolution in the zones above and below the plate (which are meshed too coarsely in the first case). It should be noted that the CPU time required for a level-4 locally adaptive calculation is less than twice the one needed for the corresponding level-3 calculation. With the same two mesh sizes, not only are the non-adaptive calculations more expensive in absolute terms, but the ratio of CPU times in that case is more than 4.

In other words, uniform-mesh calculations rapidly become impossible due to excessive CPU time as the mesh size is reduced, while locally adaptive ones remain affordable even at very fine local mesh (which is needed to have good accuracy of the FSI algorithm).

A comparison of all 6 calculations (4 without and 2 with adaptivity) is given in Figure 11 in terms of plate displacement and velocity. The finest-mesh solutions FSIA14 and FSIA09 are very similar. They are compared alone in Figure 12 for clarity.

FSIA10

This test is similar to FSIA09 but does not use the `OPTI ADAP RCON` option and a `SCAL 2.0` optional parameter in the `FLSR` directive instead.

Some results for this test are presented in Figure 13. Note how the adapted fluid mesh remains naturally graded despite the lack of the `ADAP RCON` option. The number of elements and nodes to be allocated in the adaptive process is larger than in case FSIA09, but this is normal since the refined zone is larger. However, the number of fluid nodes interacting with the structure, and thus the mass of fluid “attached” to the structure, is exactly the same in the two cases. This solution is very similar to FSIA09.

The finest-mesh solutions FSIA14 and FSIA10 are very similar. They are compared in Figure 14.

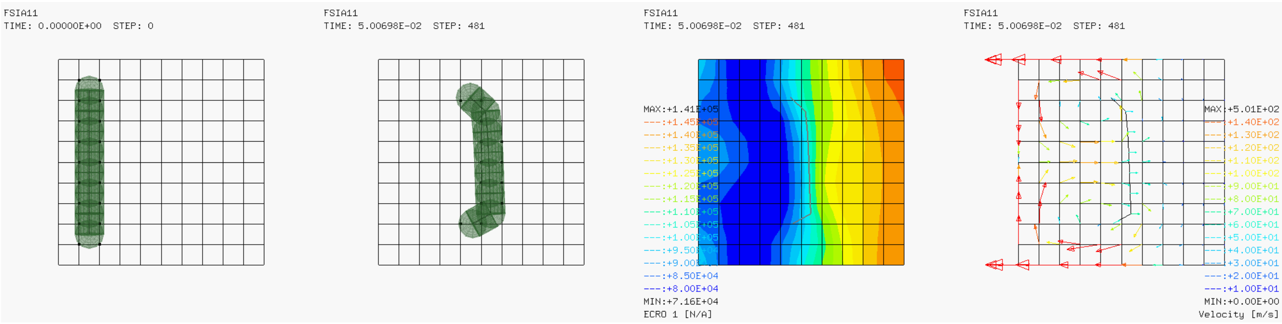


Figure 4 - Some results for test FSIA11

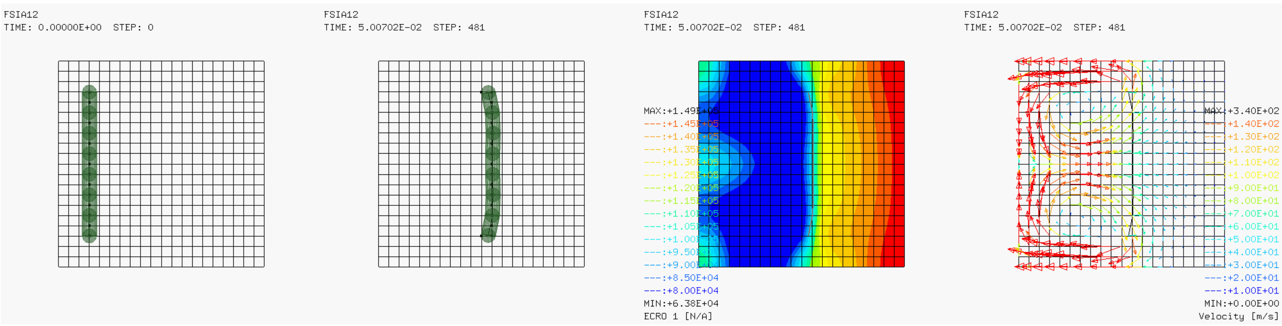


Figure 5 - Some results for test FSIA12

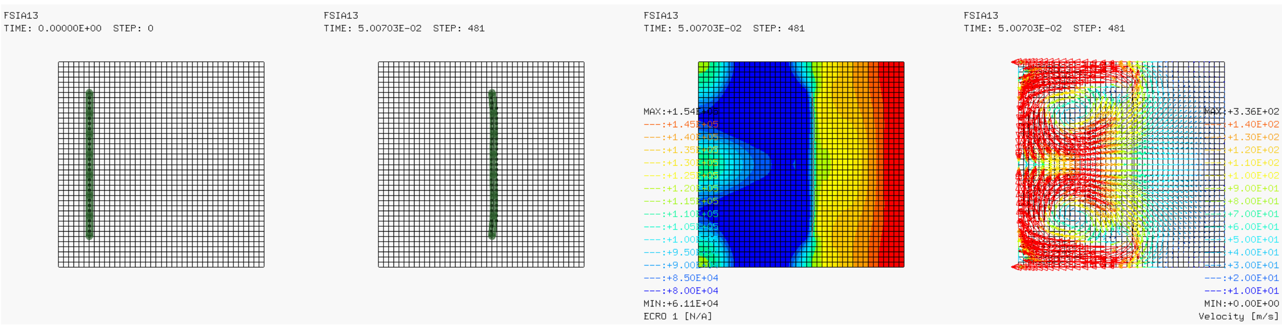


Figure 6 - Some results for test FSIA13

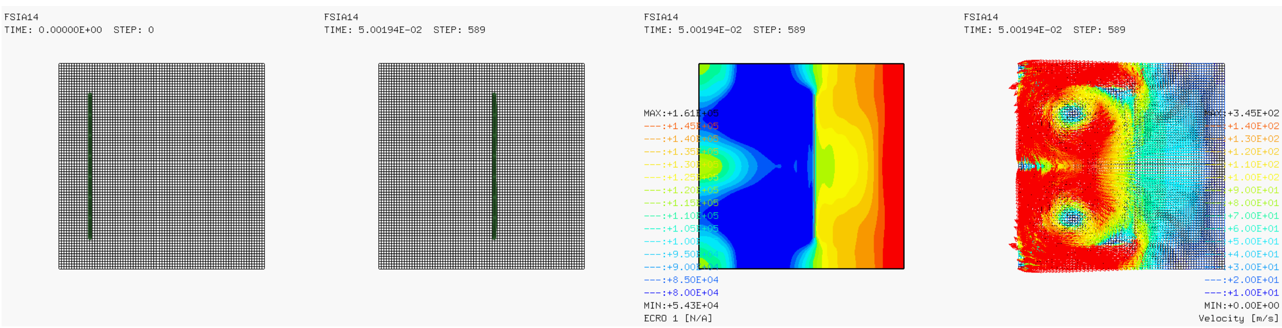
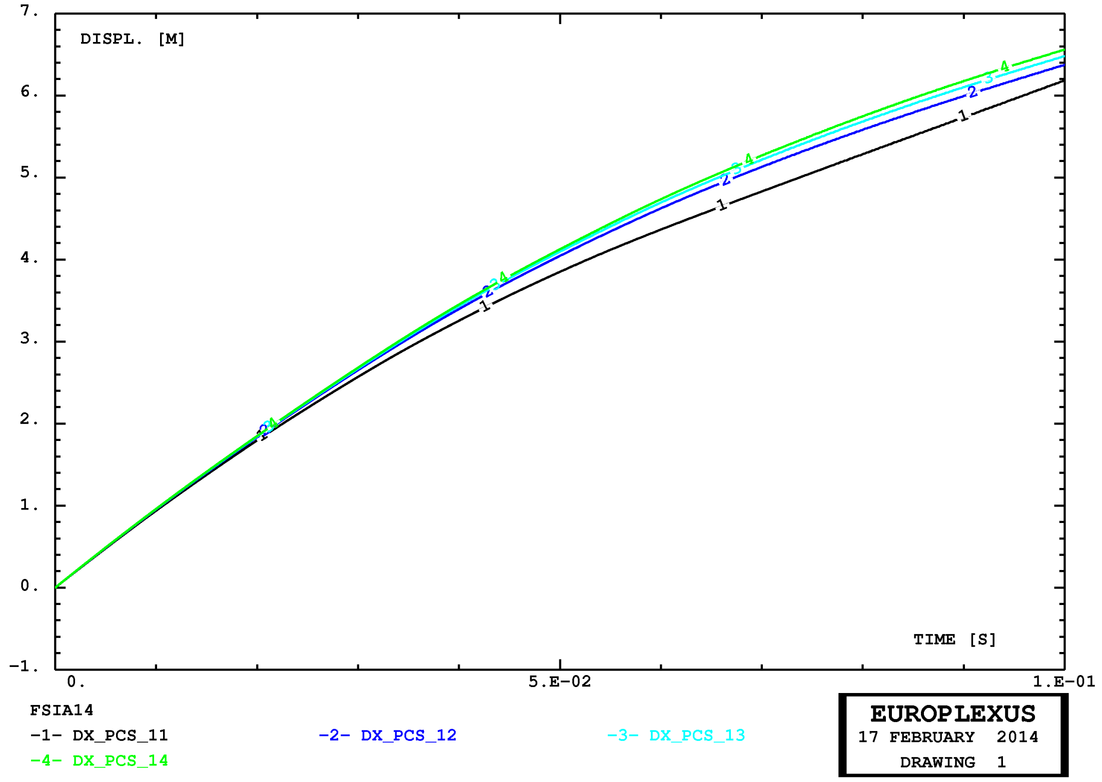


Figure 7 - Some results for test FSIA14



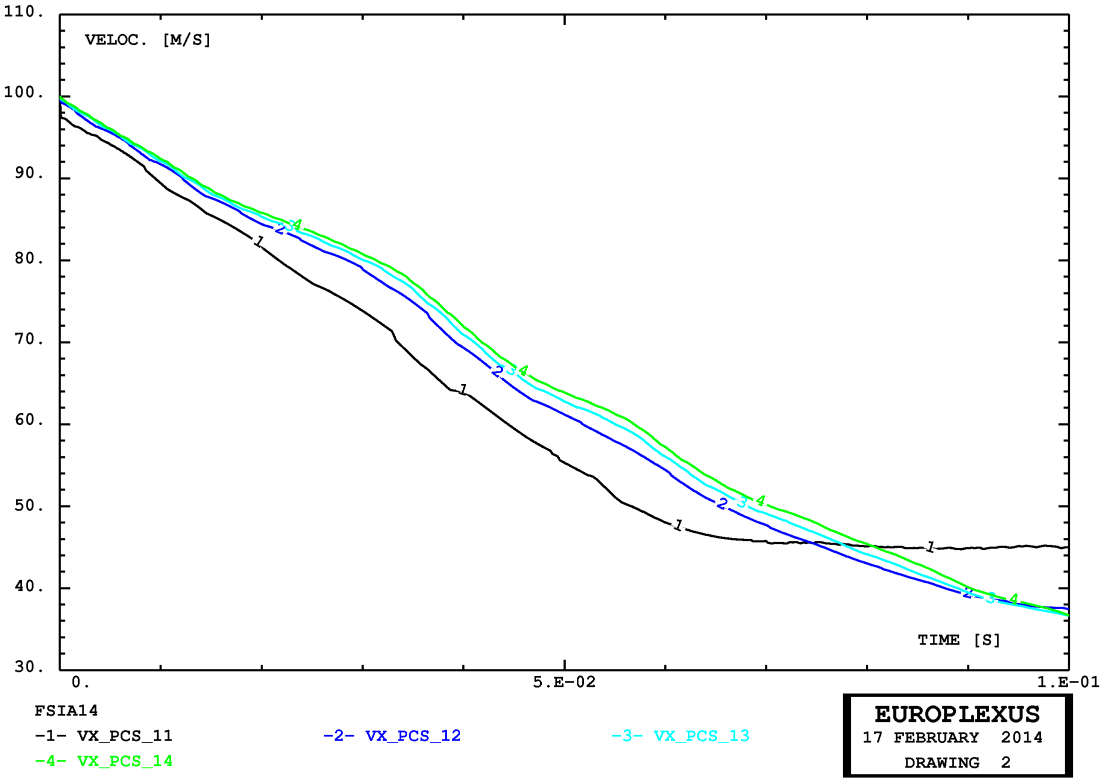


Figure 8 - Comparison of results for tests FSIA11, FSIA12, FSIA13 and FSIA14

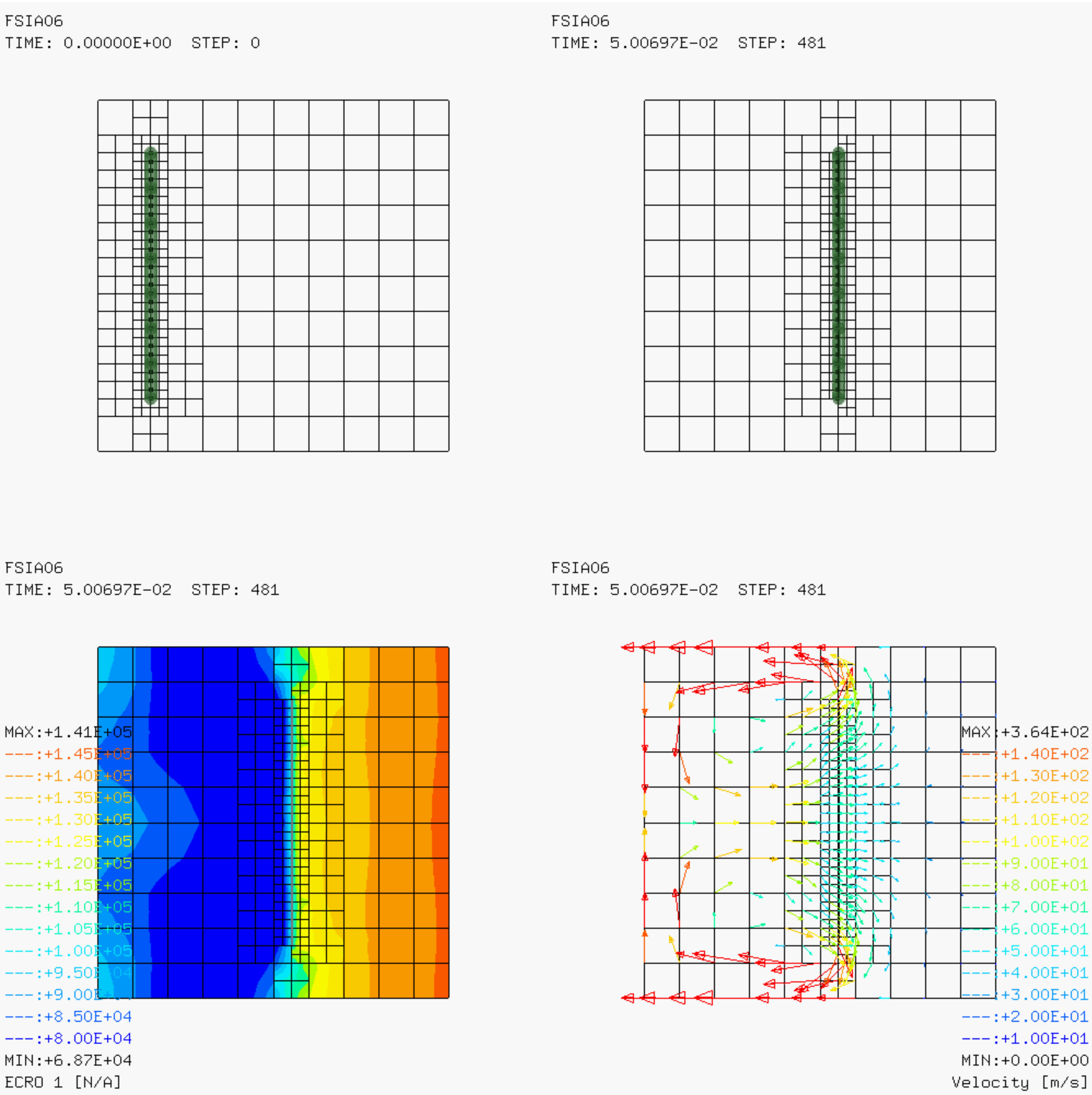


Figure 9 - Some results for test FSIA06

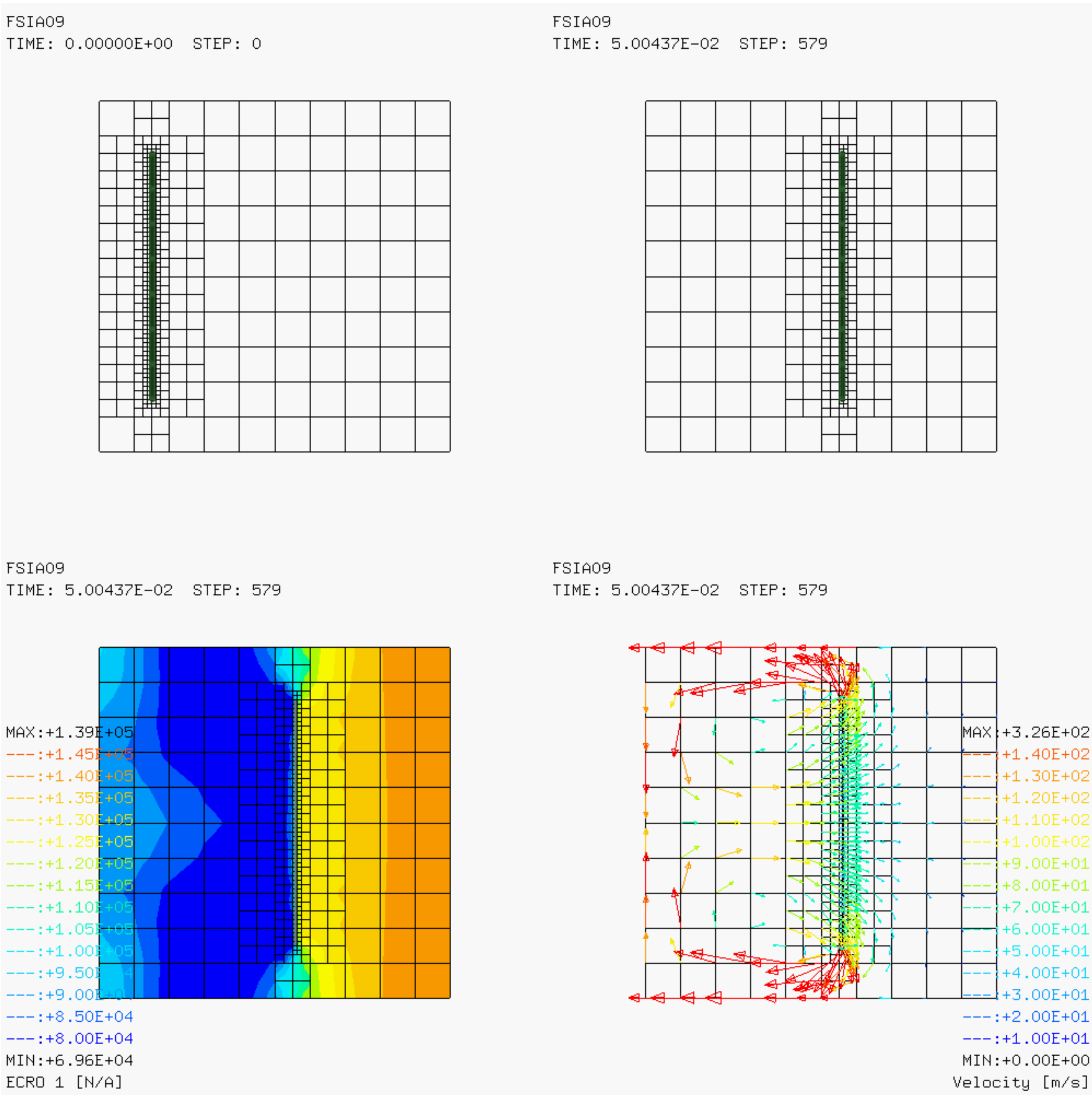
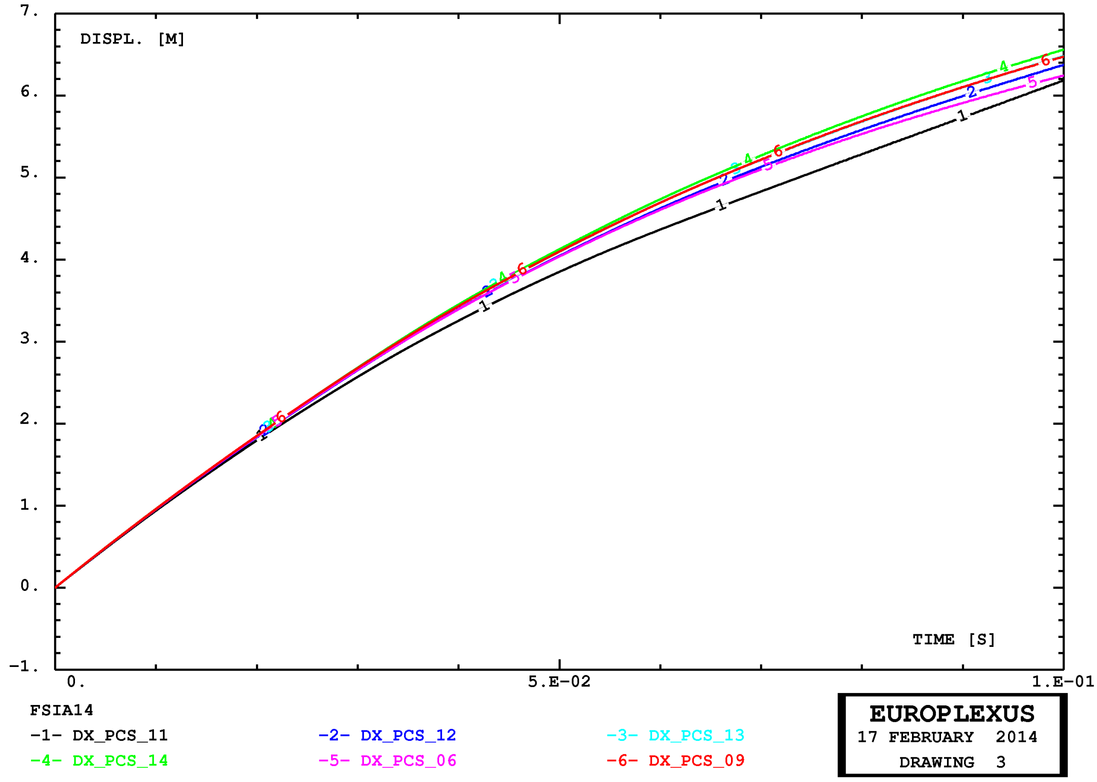


Figure 10 - Some results for test FSIA09



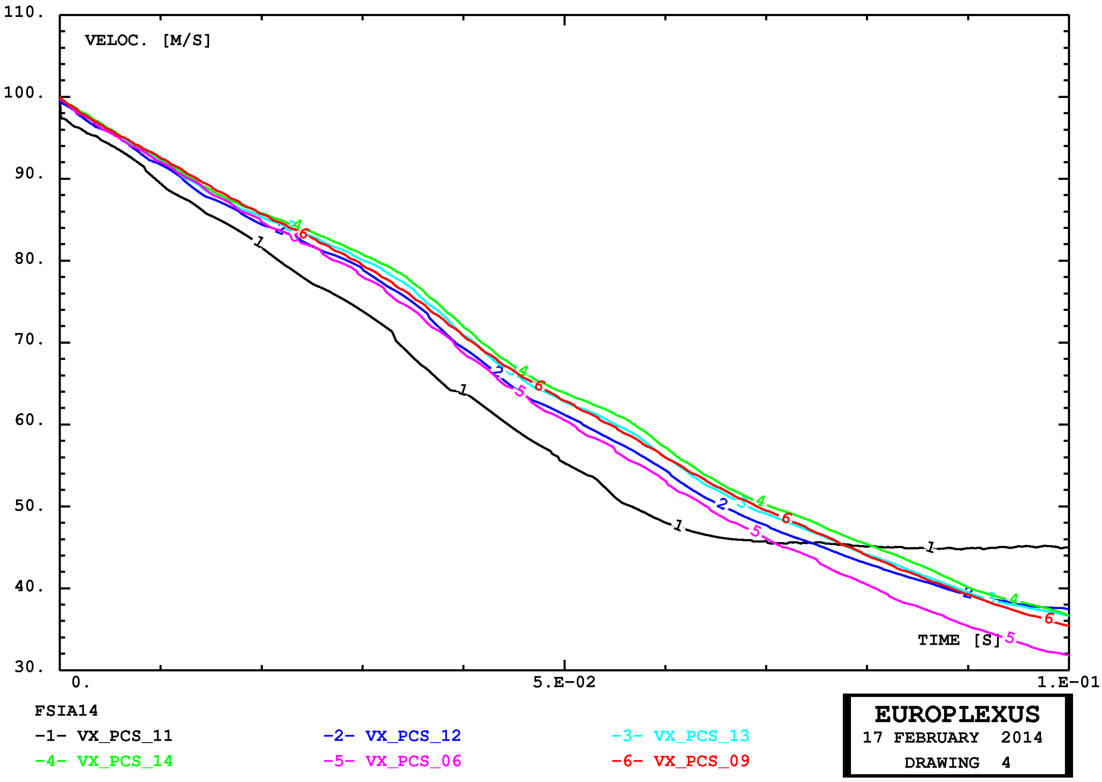
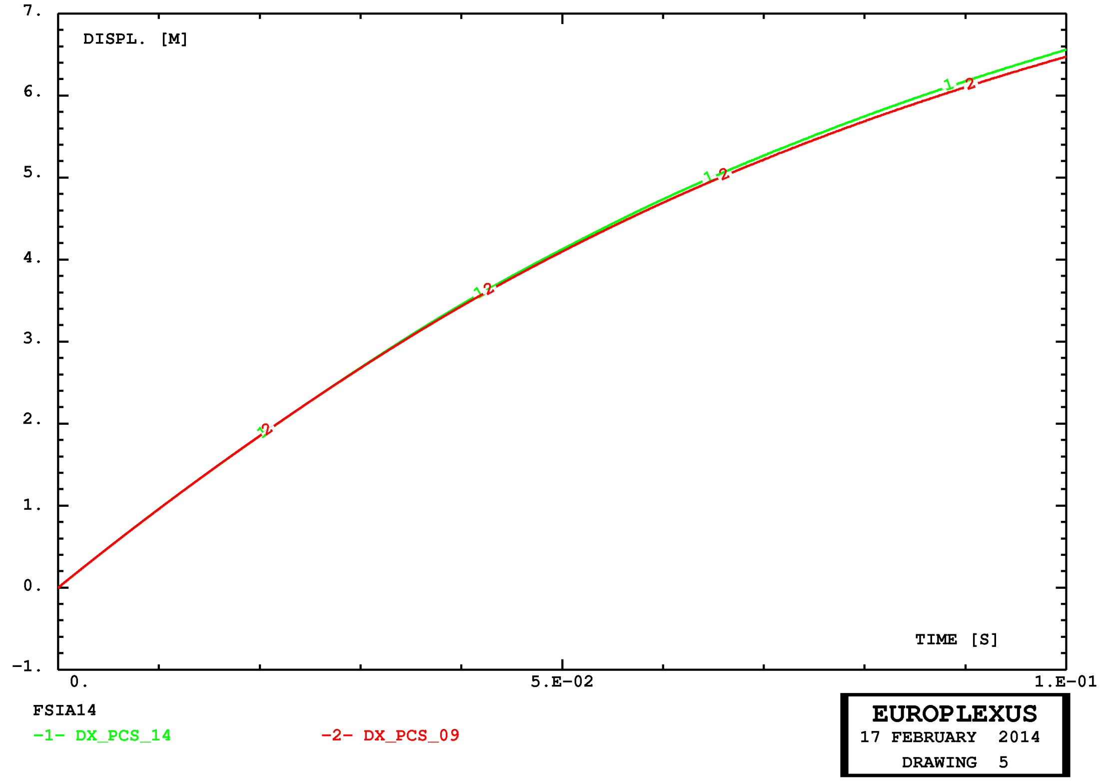


Figure 11 - Comparison of results for tests FSIA11, FSIA12, FSIA13, FSIA14, FSIA06 and FSI09



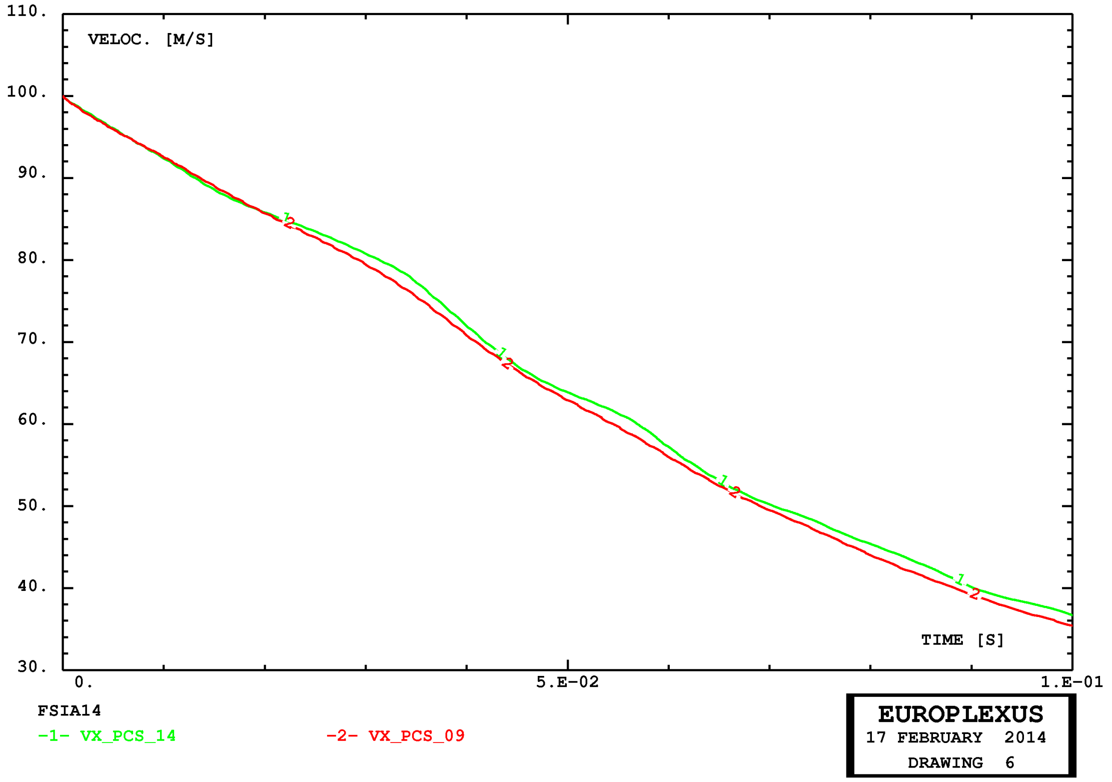


Figure 12 - Comparison of results for tests FSIA14 and FSIA09

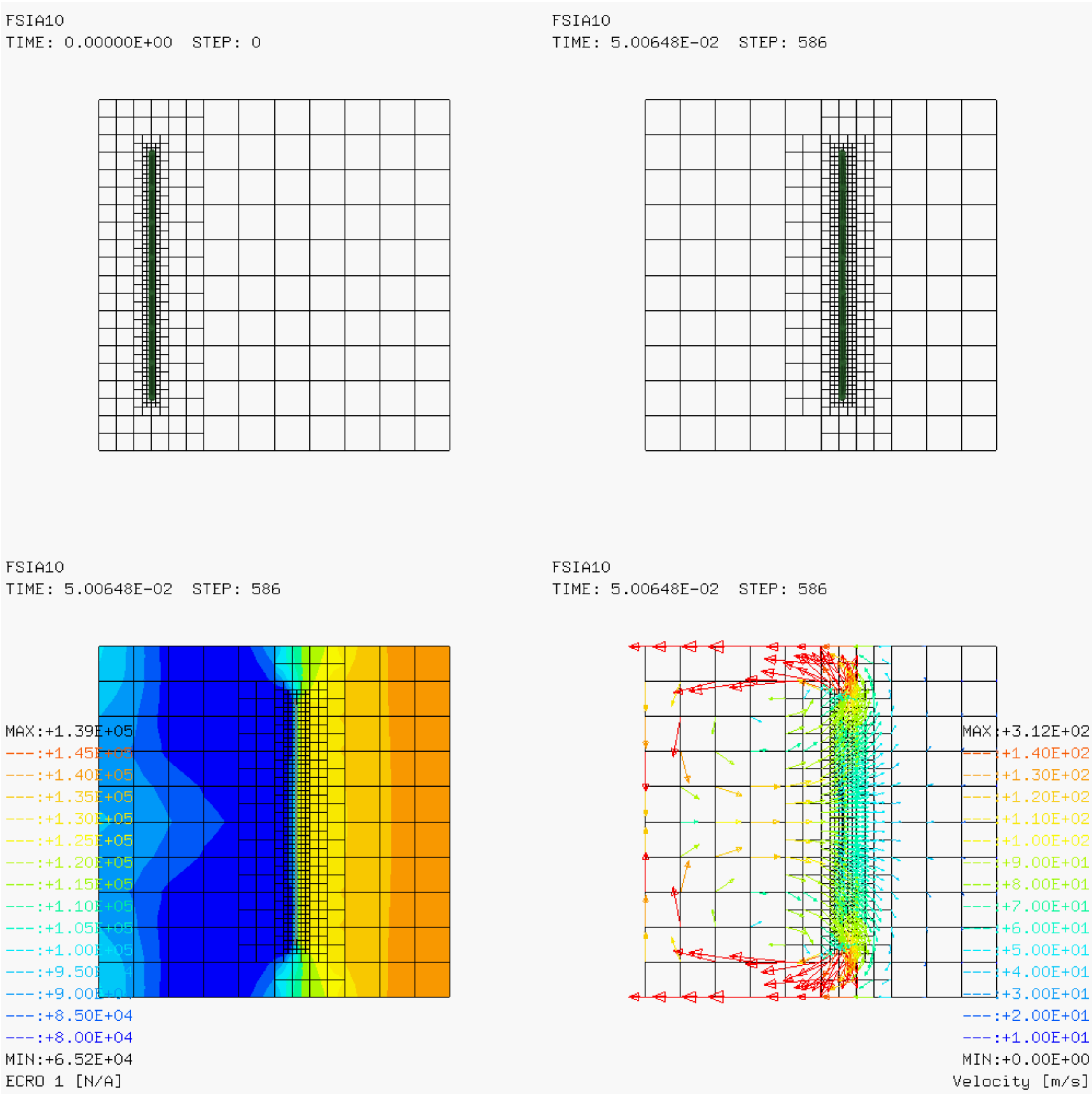
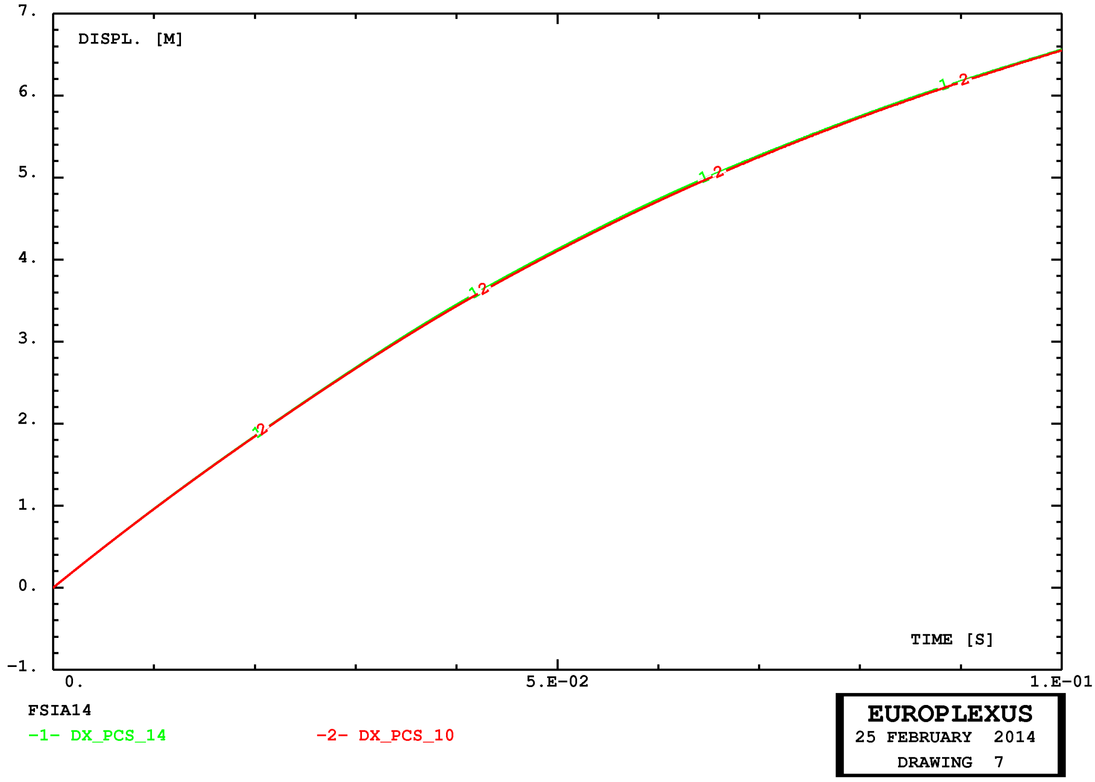


Figure 13 - Some results for test FSIA10



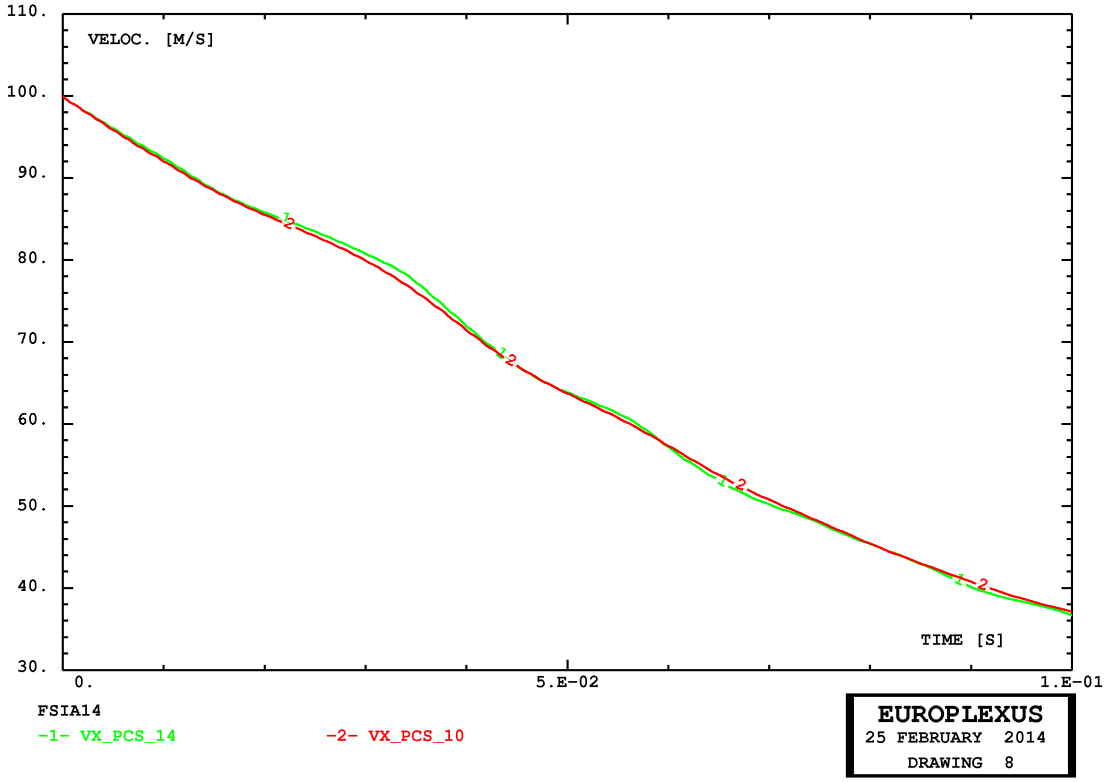


Figure 14 - Comparison of results for tests FSIA14 and FSIA10

3.2 Flying plate in 3D

The next example is the 3D version of the flying plate shown in the previous Section, see Figure 15. The plate is square in shape with side 7 m and is located at $x = 1.5$ m. It is modelled by 49 shell elements of type Q4GS.

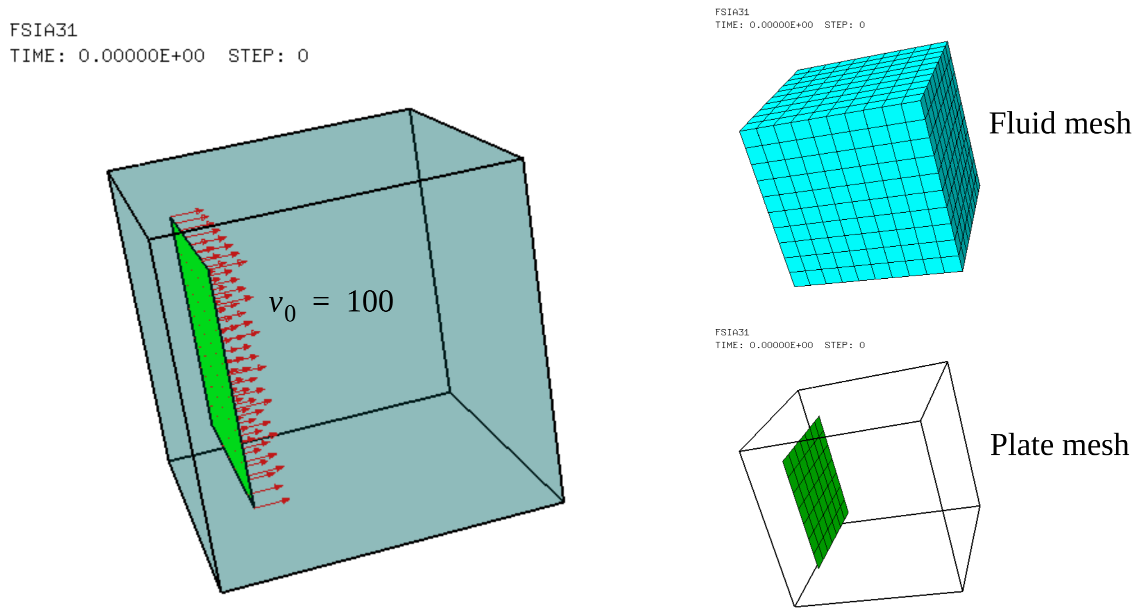


Figure 15 - Definition and initial mesh of the flying plate problem in 3D

First, a reference solution is obtained by means of non-adaptive calculations with more and more refined fluid meshes. Then, adaptive calculations are tested. All performed calculations are summarized in Table 2.

Case	Fluid Mesh	Notes	Steps	CPU [s]	Els*step
FSIA31	1,000 FL38	No adaptivity	966	5.9	1,014,383
FSIA32	8,000 FL38	No adaptivity	962	41.7	7,751,187
FSIA33	64,000 FL38	No adaptivity	962	428.4	61,679,187
FSIA26	base: 1000 FL38	ADAP LMAX 3, RCON	966	919.2	5,172,782

Table 2 - Calculations for the FSIA problem in 3D with FE in the fluid domain

3.2.1 Solutions without mesh adaptivity

FSIA31

This test uses a very coarse fluid mesh, of just $10 \times 10 \times 10$ FL38 hexahedral fluid elements. The initial FLSR structural domains and coupled fluid nodes are shown in the first part of Figure 16. Then are shown the same quantities, the pressure field and the velocity field at 50 ms (half of the transient calculation) when the fluid flow is already well-developed.

FSIA32

This test is similar to the previous one but uses a more refined fluid mesh, of $20 \times 20 \times 20$ FL38 hexahedra. Some results of this test are shown in Figure 17.

FSIA33

This test is similar to the previous one but uses a more refined fluid mesh, of $40 \times 40 \times 40$ FL38 hexahedra. Some results of this test are shown in Figure 18.

Figure 19 compares results of all three calculations, showing the displacement and velocity of a node near the center of the plate. It can be seen that, apart the coarsest-mesh case (FSIA31), the solution is only slightly sensitive to fluid mesh fineness, if one considers only the plate motion. We will assume as reference the solution with the finest mesh (FSIA33), i.e. the cyan curves in Figure 19.

3.2.2 Solutions with mesh adaptivity

FSIA26

This test uses a base fluid mesh of $10 \times 10 \times 10$ FL38 hexahedra fluid elements, exactly like in case FSIA31. However, in the FLSR directive we specify `ADAP LMAX 3`, i.e. adaptive refinement near the structure up to a level 3 (thus a refinement of up to a factor 4 with respect to the base mesh), which would correspond to a fluid mesh of the same size locally as case FSIA33. Some results of this test are shown in Figure 20. In this case use has been made of the `OPTI ADAP RCON` option without any ping-pong effects being detected by the dedicated check.

The solution is reasonably similar to the one of case FSIA33.

A comparison of all 4 calculations (3 without and 1 with adaptivity) is given in Figure 21 in terms of plate displacement and velocity. The finest-mesh solutions FSIA33 and FSIA26 are very similar. They are compared alone in Figure 22 for clarity.

As it results from Table 2, the cost of the adaptive calculation FSIA26 is 2.15 times *higher* than that of the correspondingly fine calculation without adaptivity, which is very disappointing. However, there is an explanation for this. In the case of FLSR, the coupling between fluid an structure is done in a strong manner, i.e. by means of Lagrange multipliers, or kinematic *links*. In addition to these links, some other links are also required at the so-called hanging nodes generated in the adaptive mesh refinement. From the listings of the calculations, one can see that already in case FSIA33 the code spends 53% of the CPU time in solving the links, and only 43% in computing the elements. This is due to several reasons:

- First of all, the standard Choleski solver is employed, which can be relatively inefficient on large systems.

- Second, in case of strong coupling between a relatively coarse structure and a (much) finer fluid mesh, the bandwidth of the system is known to increase, so that the system solution takes more time.
- Third, by default the code splits the links in several independent sub-systems. This operation may be inefficient in some cases and can increase substantially the CPU time.

In the adaptive calculation FSIA26, in addition to the FLSR links we have also the adaptivity-related links at hanging nodes (this is so because we are using FE for the fluid domain in this solution). The result is that the code spends as much as 97% of CPU time in solving the links, and only 2% in computing the elements. The result is that this calculation costs more than the non-adaptive one.

To ameliorate the situation, one may try the following:

- Use a more efficient system solver, such as SPLIB. (`SOLV SPLI`).
- Refine the structure mesh. Although this will augment the number of structure elements and reduce the associated time step, the bandwidth of the links system will decrease. Sometimes the global effect of all these parameters is a reduction of the CPU time (rather than an increase as it would seem logical).
- Avoid splitting the links system (`SPLT NONE`). The solution of a monolithic system is sometimes faster than splitting and then solving several independent subsystems, since the solver is quite efficient.

Note that in theory all these drawbacks are avoided if one uses a weak, rather than a strong, F-S coupling. To this end, one might try out the decoupled (weak) version of FLSR (activated by directive `LINK DECO FLSR` instead of `LINK COUP FLSR`), which could work provided there is no physical interaction between the FSI constraints and other constraints (such as blockages on the fluid envelope or constraints at hanging nodes).

Even better, one could avoid all these drawbacks by using the CCFV formulation for the fluid domain, and the associated weak coupling `LINK DECO FLSW`. A further advantage, in this case, would be that no links are needed on the fluid envelope, and also no links are needed at hanging nodes, because the velocities are at the cell centres and not at nodes in this case. Thus, an adaptive calculation with CCFV would require no links at all. Such a calculation is presented in Section 4.2.

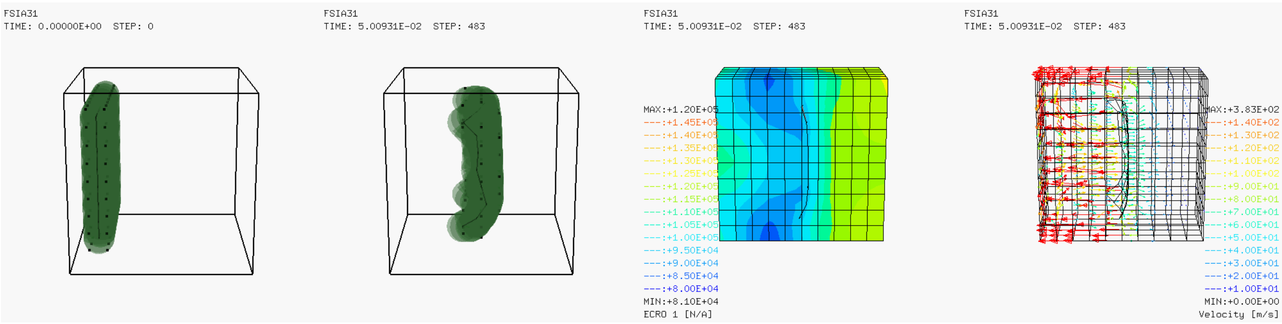


Figure 16 - Some results for test FSIA31

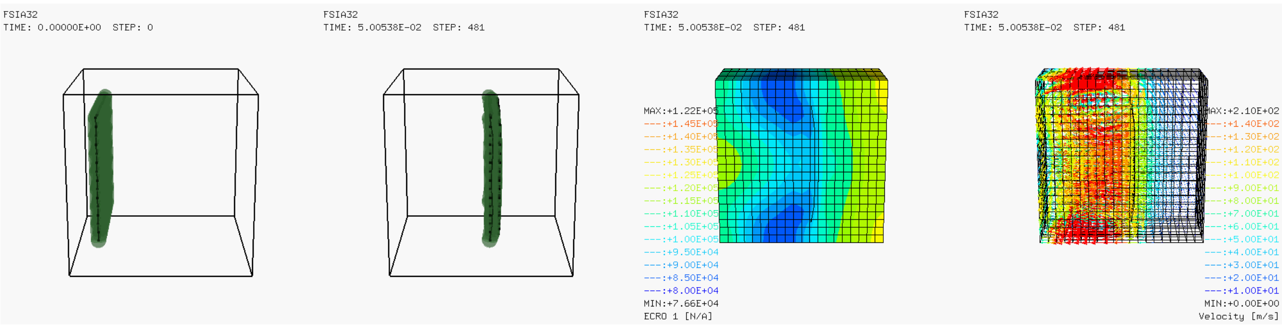


Figure 17 - Some results for test FSIA32

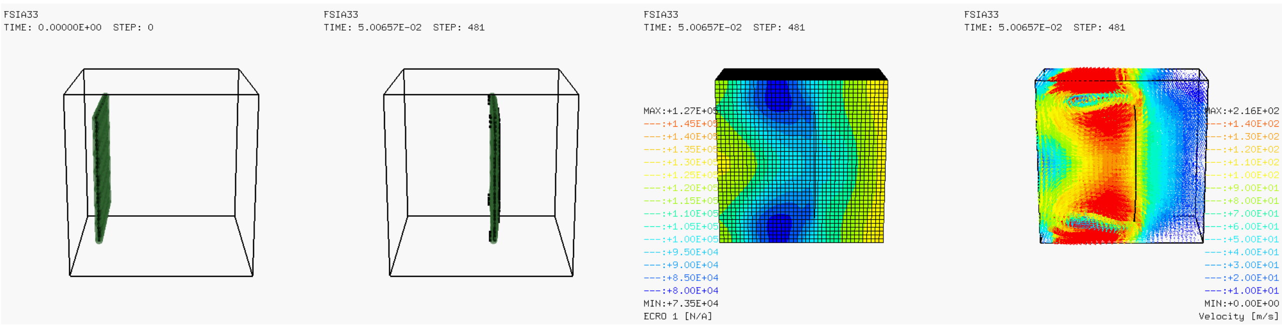
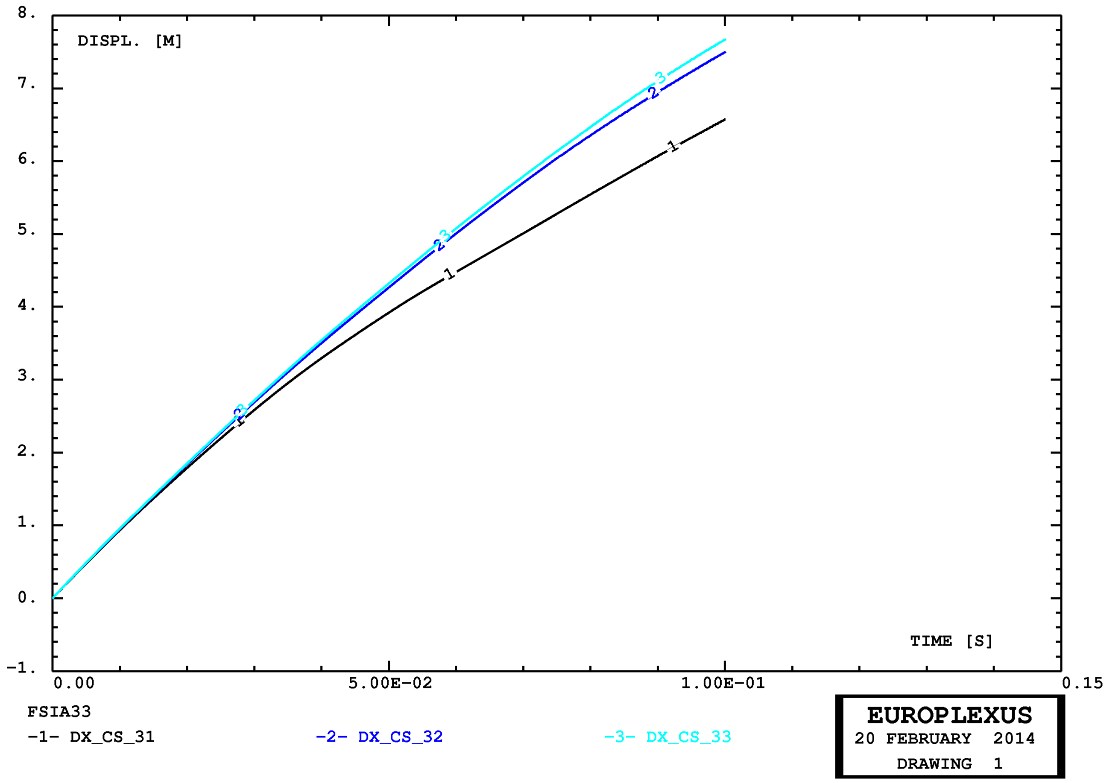


Figure 18 - Some results for test FSIA33



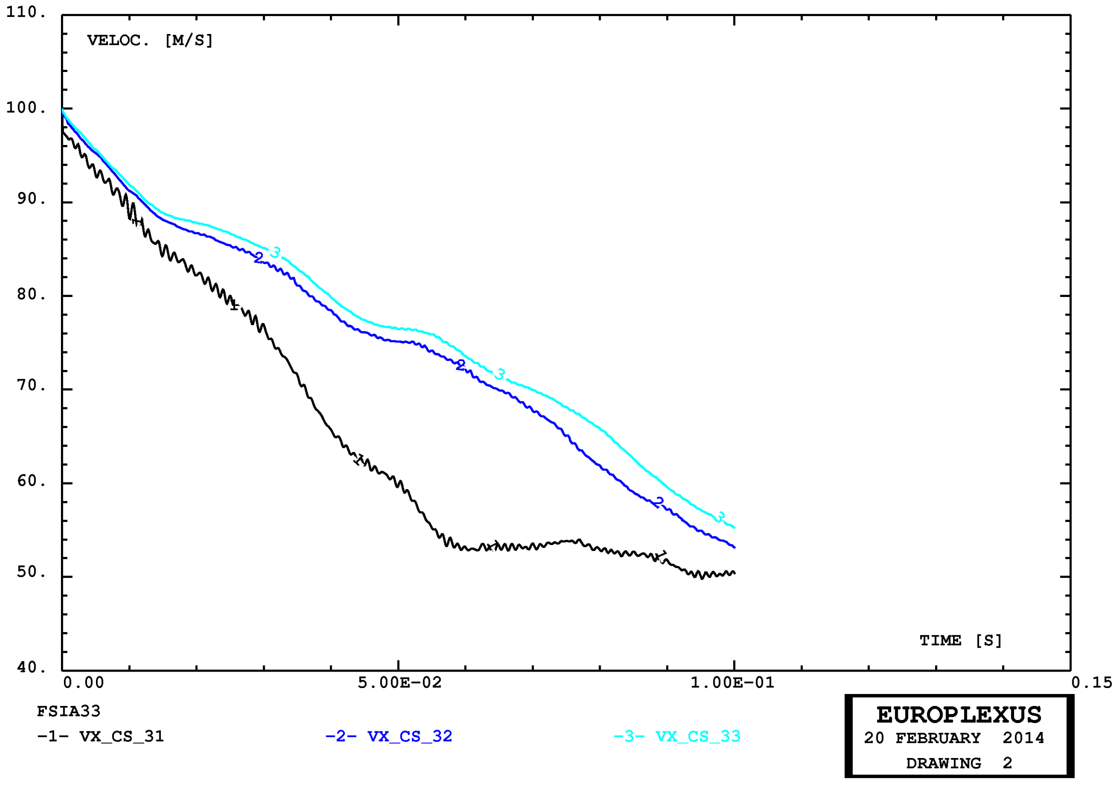


Figure 19 - Comparison of results for tests FSIA31, FSIA32 and FSIA33

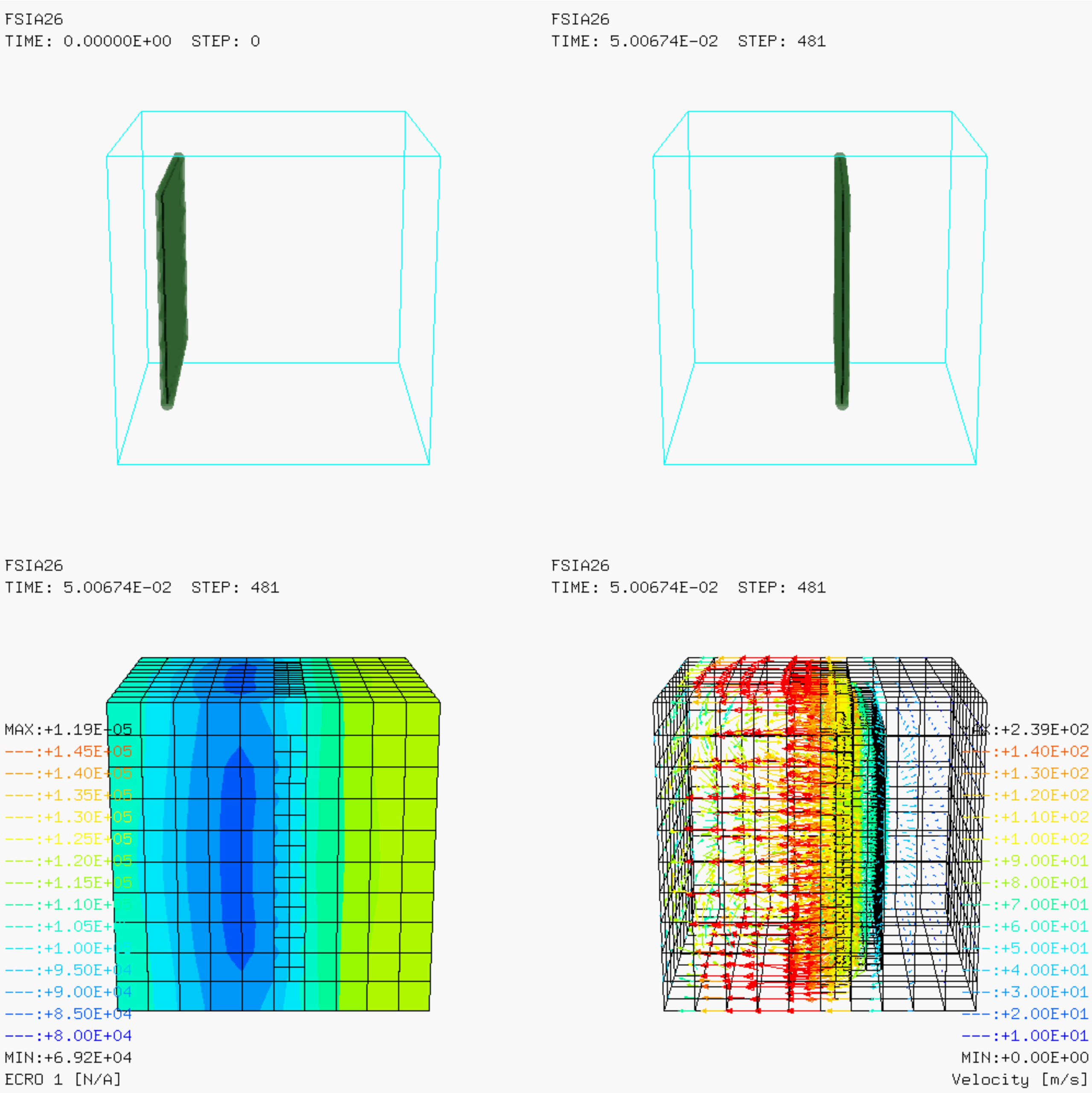
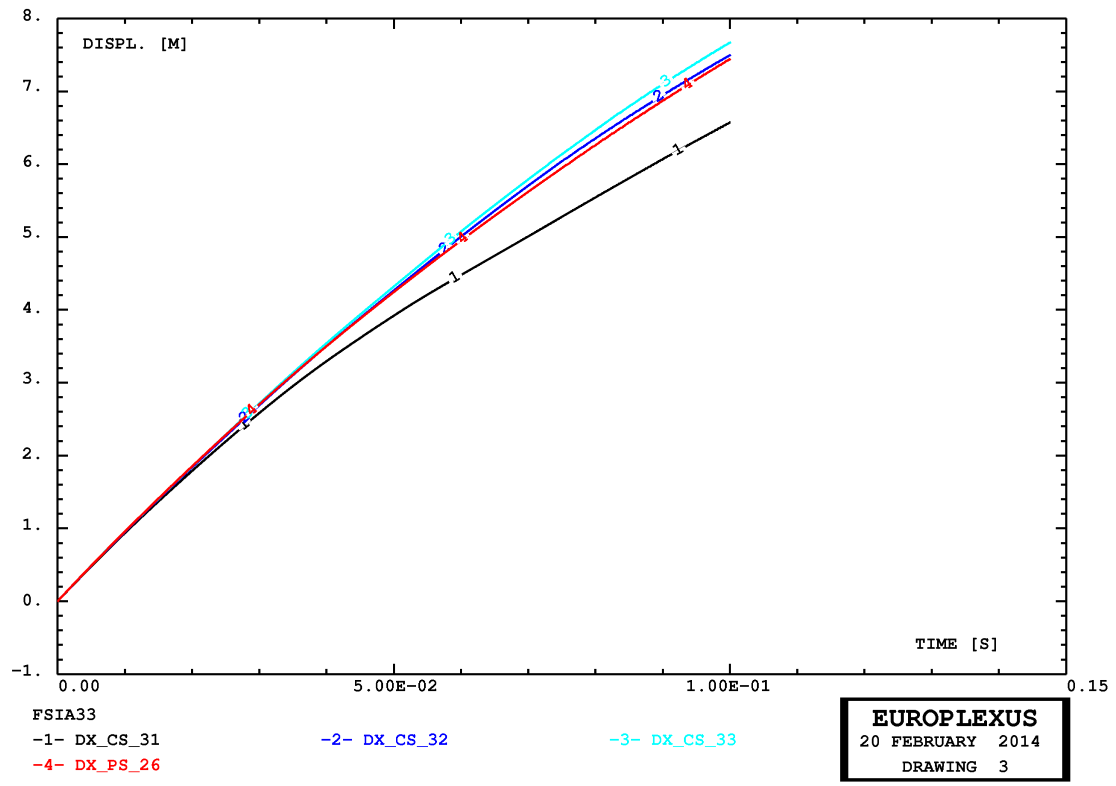


Figure 20 - Some results for test FSIA26



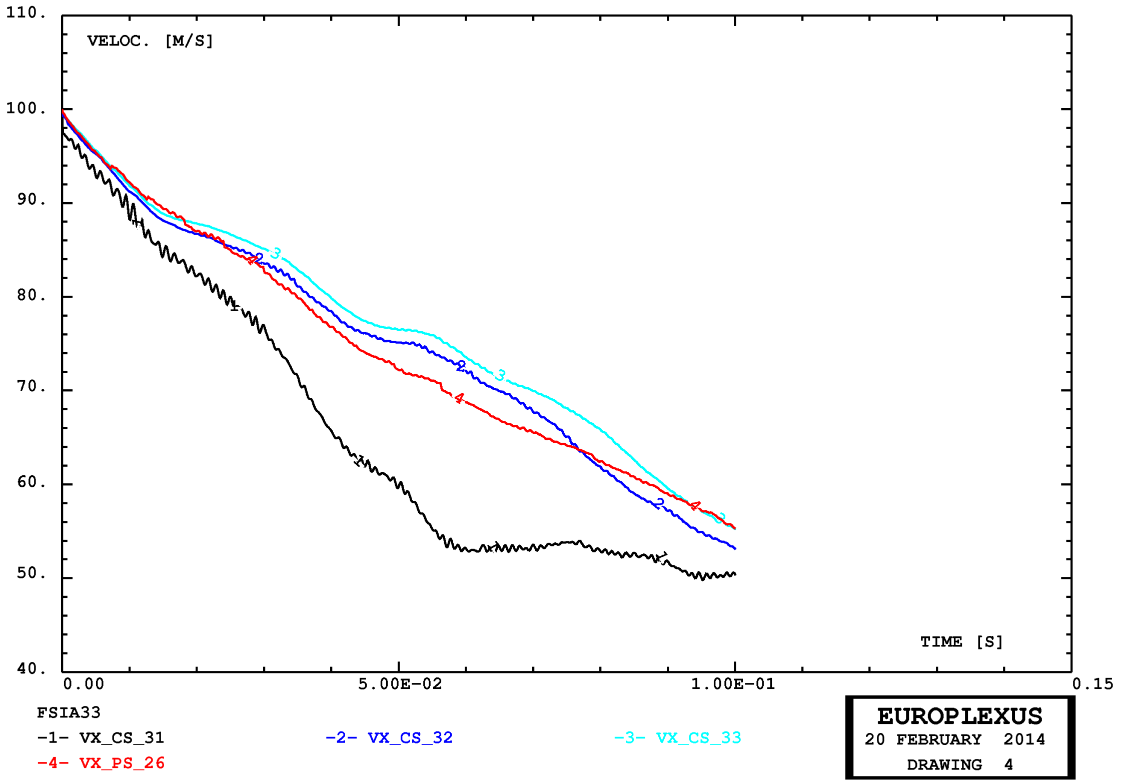
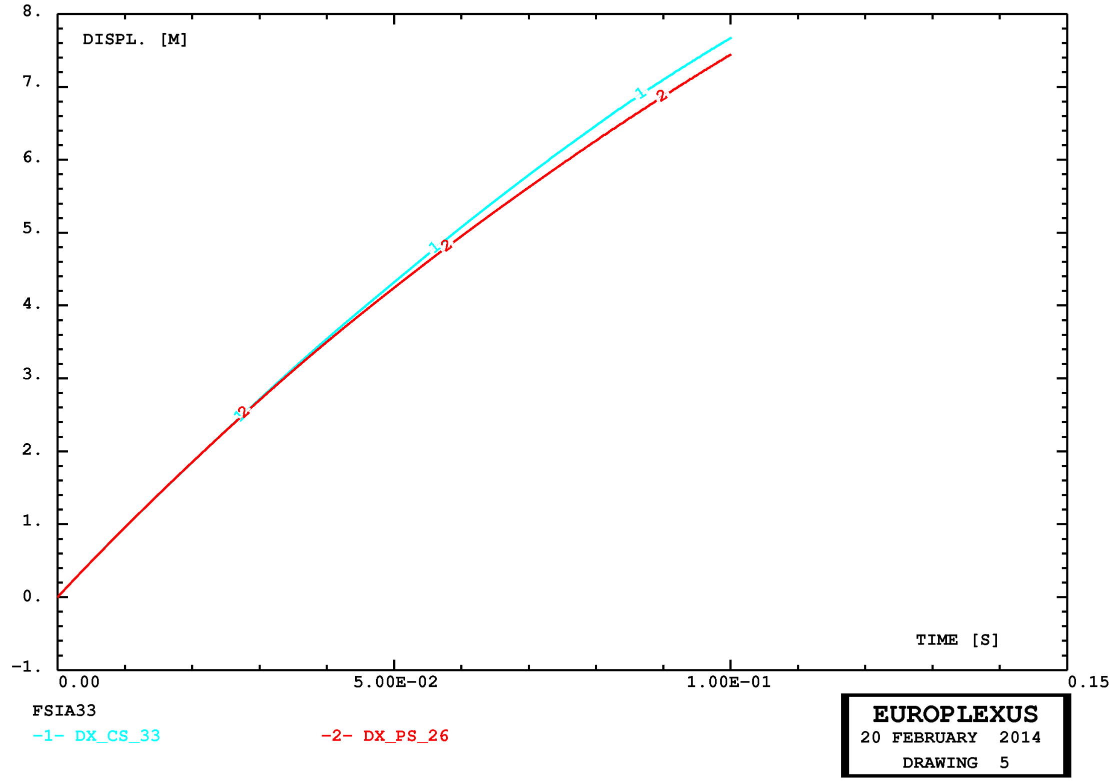


Figure 21 - Comparison of results for tests FSIA31, FSIA32, FSIA33 and FSIA26



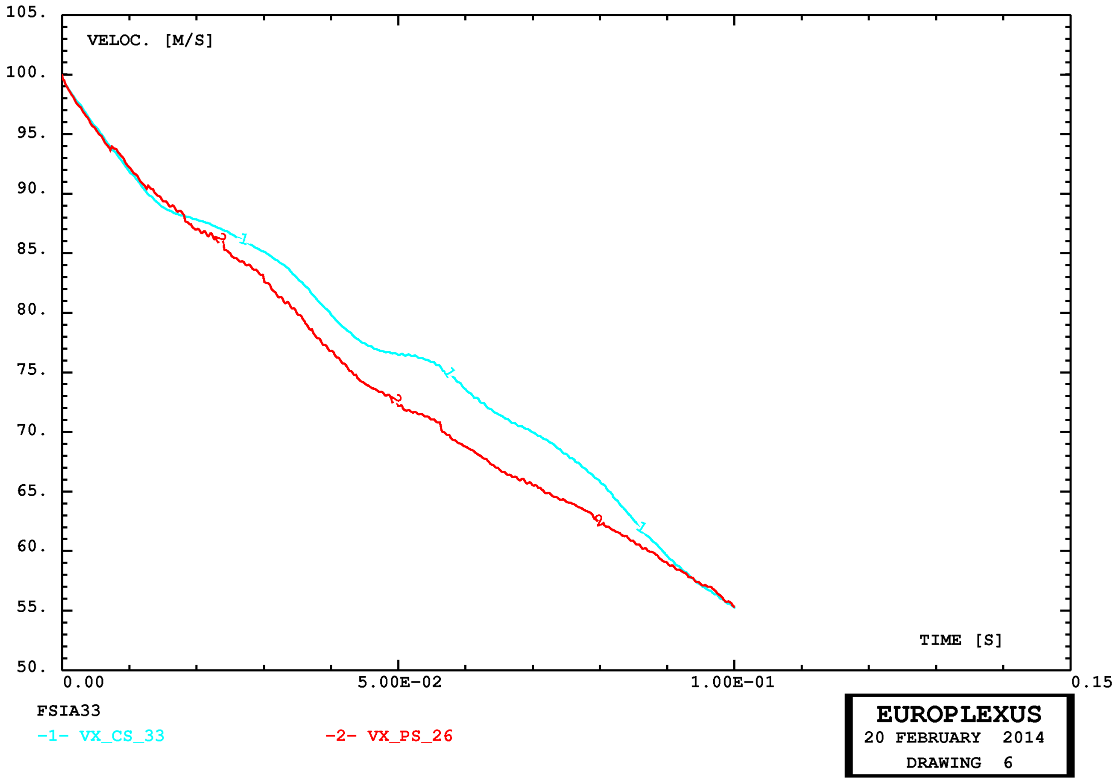


Figure 22 - Comparison of results for tests FSIA33 and FSIA26

3.3 Rotating mill

The second example is that of a metallic mill rotating at a certain initial velocity within a square domain containing a compressible fluid, see Figure 23. The fluid domain (perfect gas material) has a dimension of 10×10 m and its walls are rigid (but the fluid can slide along the walls without any resistance). The mill, made of steel-like elasto-plastic material, is located at the centre of the fluid domain, has two blades of length 8 m each and an initial velocity of 80 m/s at the blade tips (linear initial velocity distribution along the blades). In all cases, the mill is modelled by just 16 shell elements of type ED01 (8 elements in each blade).

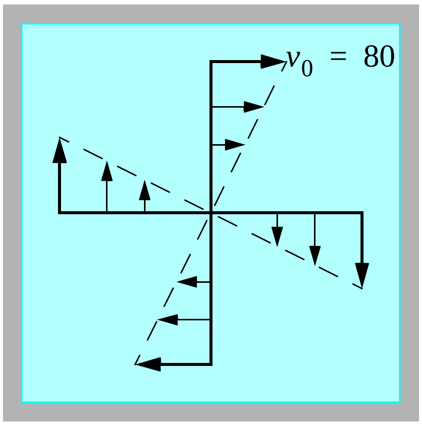


Figure 23 - Definition of the mill problem

First, a reference solutions is obtained by means of non-adaptive calculations with more and more refined fluid meshes. Then, adaptive calculations are tested. All performed calculations are summarized in Table 3.

Case	Fluid Mesh	Notes	Steps	CPU [s]	Els*step
MILL11	100 FL24	No adaptivity	961	0.8	111,592
MILL12	400 FL24	No adaptivity	961	1.3	400,192
MILL13	1,600 FL24	No adaptivity	961	3.4	1,554,592
MILL14	6,400 FL24	No adaptivity	962	12.2	6,178,608
MILL02	base: 100 FL24	ADAP LMAX 4, RCON	1,002	7.1	751,064
MILL04	base: 100 FL24	ADAP LMAX 4 SCAL 2	1,002	6.8	1,063,776

Table 3 - Calculations for the MILL problem

3.3.1 Solutions without mesh adaptivity

MILL11

This test uses a very coarse fluid mesh, of just 10×10 FL24 quadrilateral fluid elements. The initial FLSR structural domains and coupled fluid nodes are shown in the first part of Figure 24. Then are shown the same quantities, the pressure field and the velocity field at 100 ms (end of the transient calculation) when the mill has rotated clockwise by about 100 degrees.

MILL12

This test is similar to the previous one but uses a more refined fluid mesh, of 20×20 FL24 quadrilaterals. Some results of this test are shown in Figure 25.

MILL13

This test is similar to the previous one but uses a more refined fluid mesh, of 40×40 FL24 quadrilaterals. Some results of this test are shown in Figure 26.

MILL14

This test is similar to the previous one but uses a more refined fluid mesh, of 80×80 FL24 quadrilaterals. Some results of this test are shown in Figure 27.

Figure 28 compares results of all four calculations, showing the displacement and velocity of a node at the tip of one of the blades. It can be seen that the solution is only slightly sensitive to fluid mesh fineness, if one considers only the blades motion. We will assume as reference the solution with the finest mesh (MILL14), i.e. the green curves in Figure 28.

3.3.2 Solutions with mesh adaptivity

MILL02

This test uses a base fluid mesh of 10×10 FL24 quadrilateral fluid elements, exactly like in case MILL11. However, in the FLSR directive we specify `ADAP LMAX 4`, i.e. adaptive refinement near the structure up to a level 4 (thus a refinement of up to a factor 8 with respect to the base mesh), which would correspond to a fluid mesh of the same size as case MILL14. Some results of this test are shown in Figure 29.

In this case use has been made of the `OPTI ADAP RCON` option in order to keep the adapted mesh always graded. Without this option, the jump in mesh size between two neighboring fluid elements was more than 2, in some cases. Despite use of the option, no ping-pong effects were detected by the dedicated check.

The solution is *very different* from those without adaptivity. The blades bend much more from the very beginning and plastify. Also, some parasitic high velocities are observed near the blades at the beginning of the transient. This solution is therefore considered unacceptable.

The difference in solutions can be better appreciated in Figure 30.

MILL04

This test is identical to MILL02 but uses `SCAL 2.0` instead of `OPTI ADAP RCON` in order to widen the refined zone and to keep the adapted mesh smoothly graded.

The solution now is free from parasitic velocities, and very similar to the one obtained without adaptivity and a fine mesh, case MILL14. Some results of this test are shown in Figure 31. The adapted fluid mesh remains smoothly graded during the entire transient computation.

The solution in terms of blade displacement and velocity is compared with the finest uniform-mesh solution (MILL14) in Figure 32, showing almost perfect agreement.

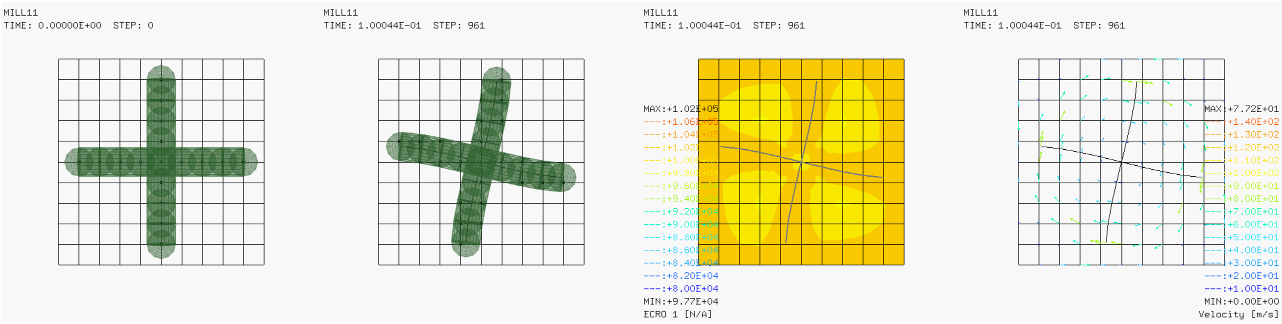


Figure 24 - Some results for test MILL11

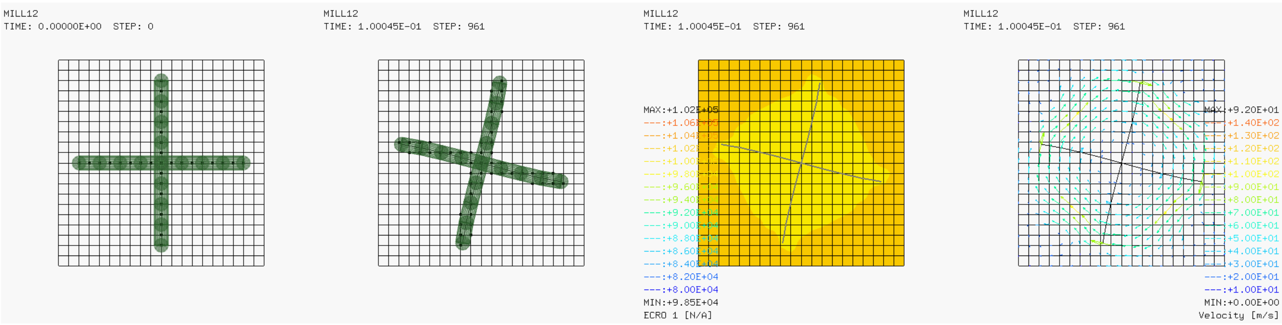


Figure 25 - Some results for test MILL12

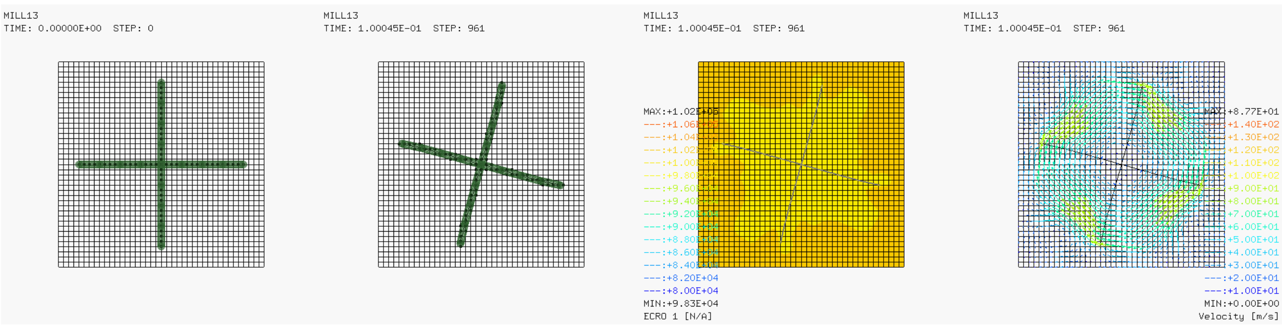


Figure 26 - Some results for test MILL13

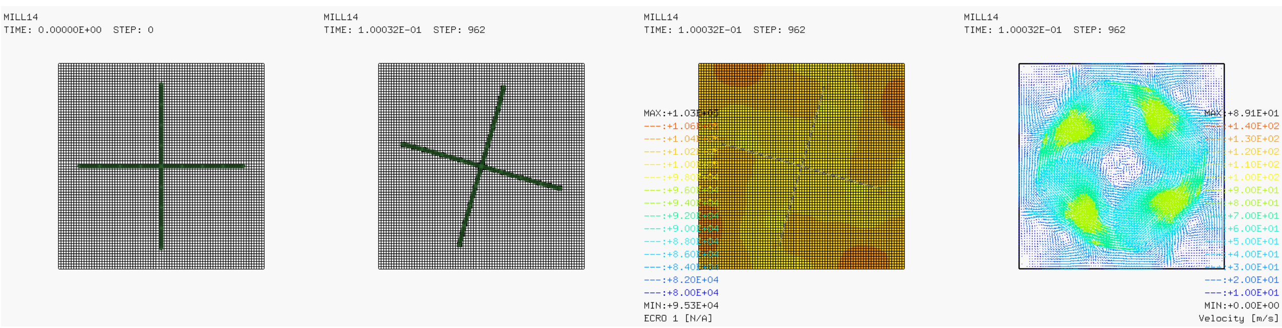
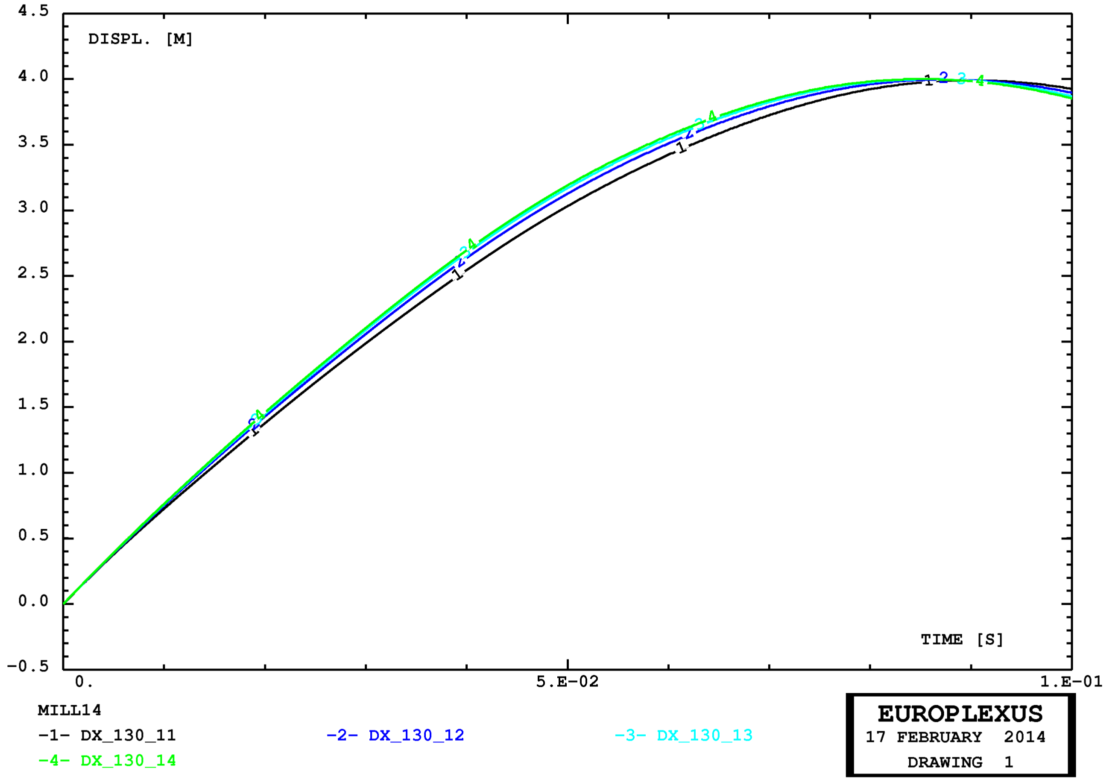


Figure 27 - Some results for test MILL14



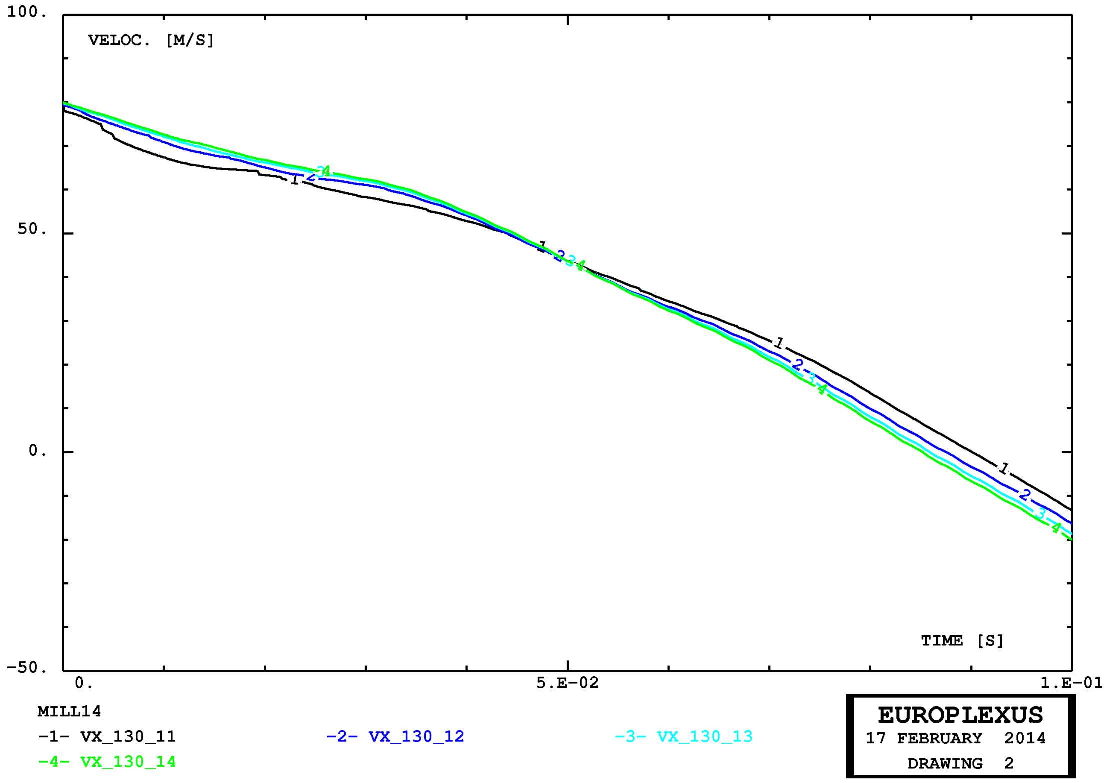


Figure 28 - Comparison of results for tests MILL11, MILL12, MILL13 and MILL14

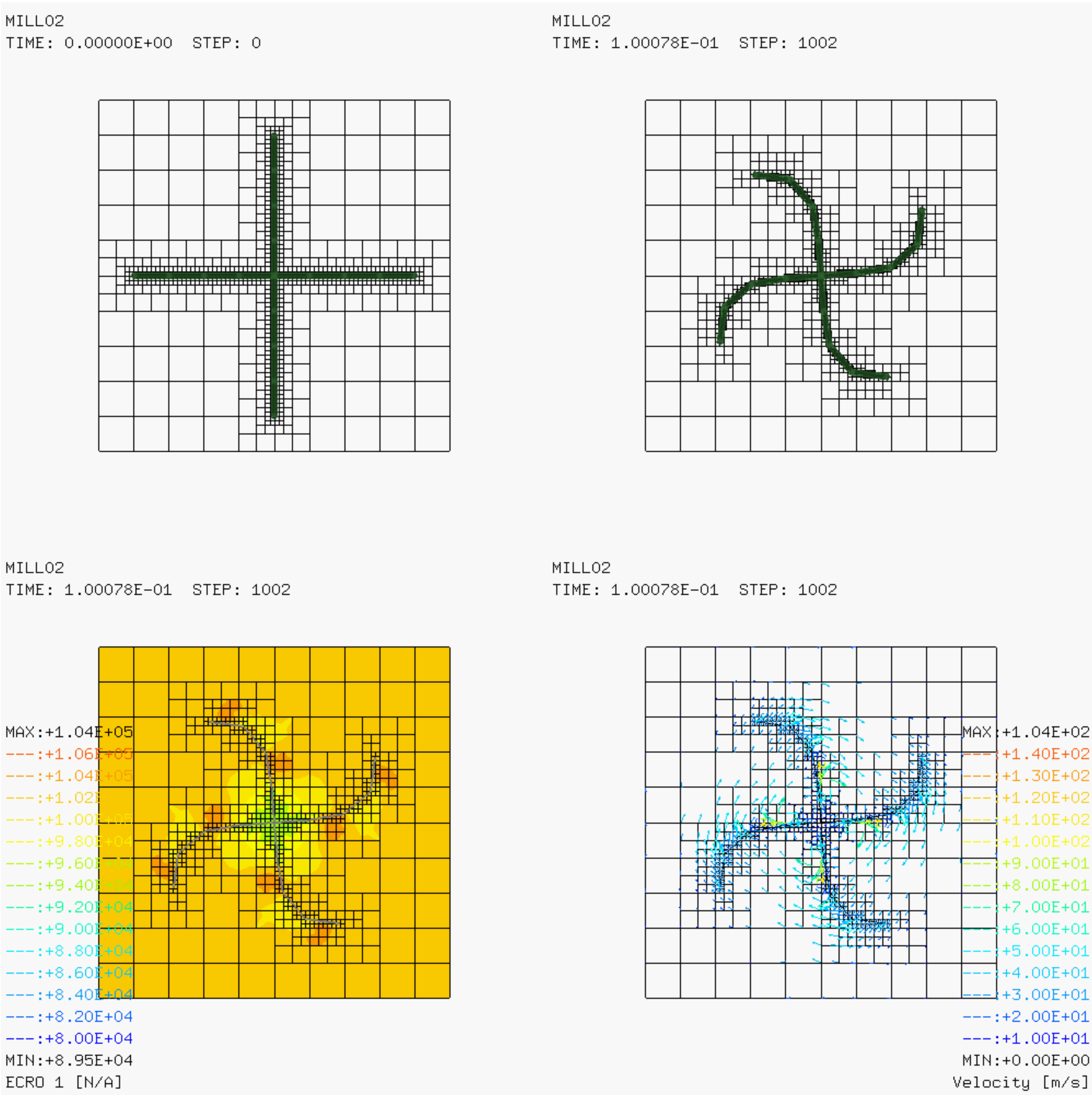
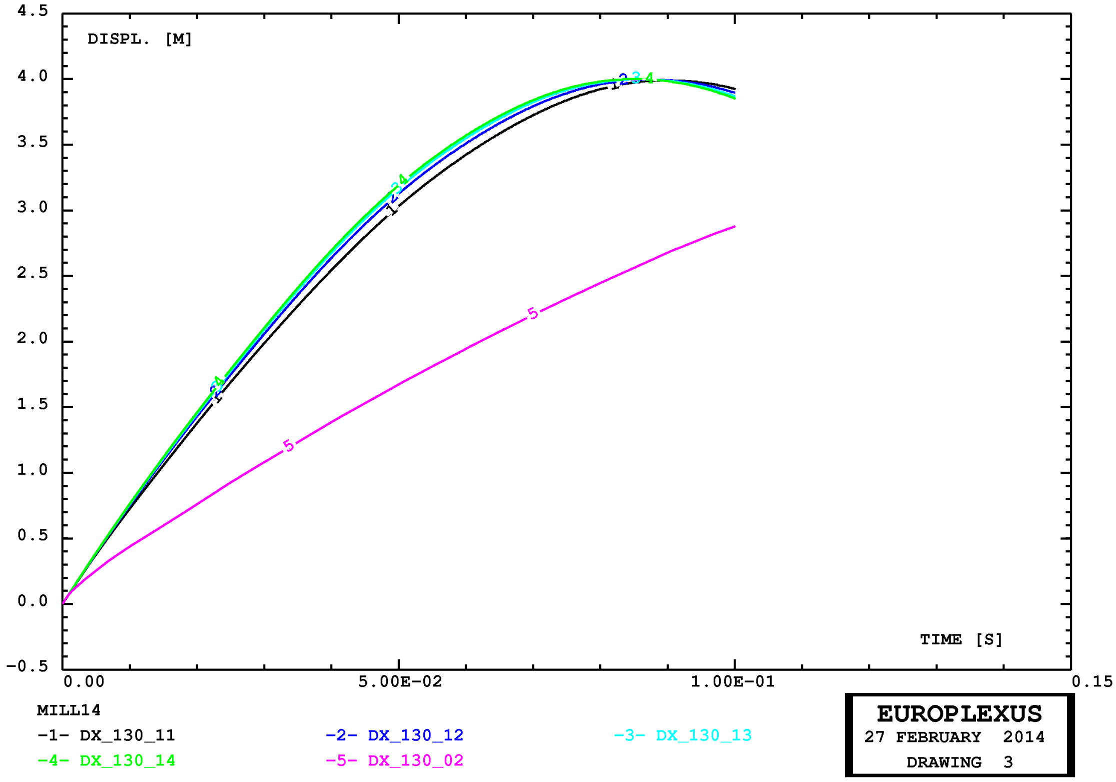


Figure 29 - Some results for test MILL02



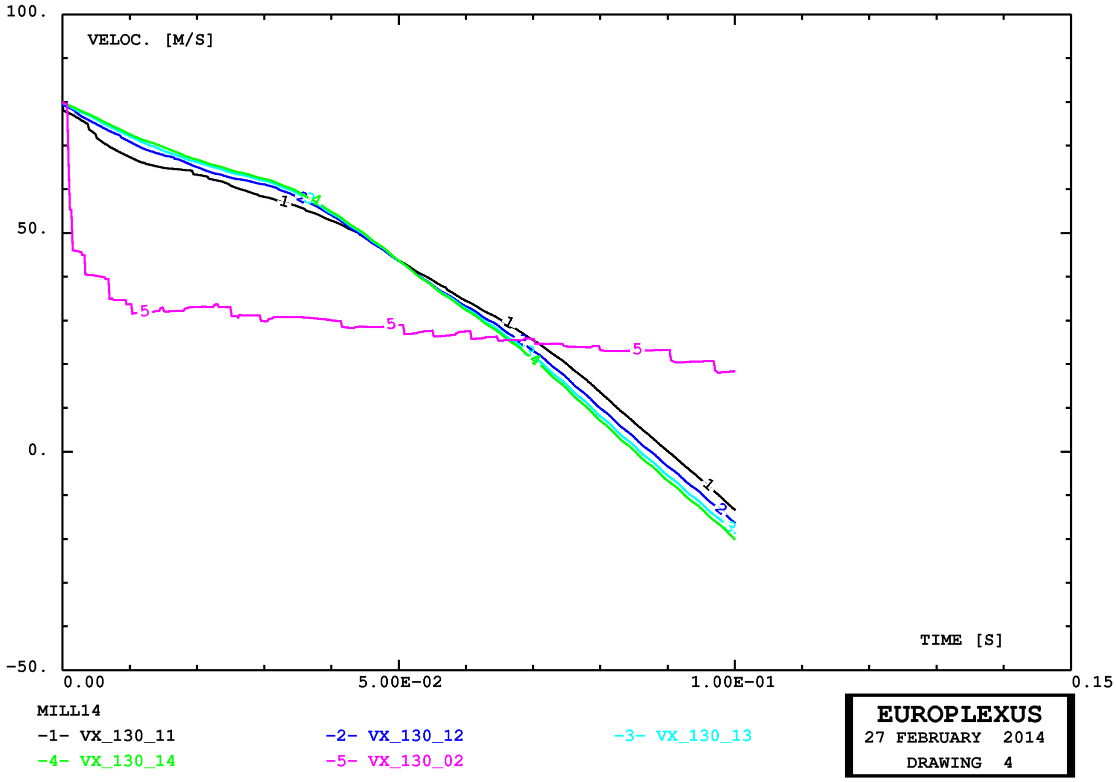


Figure 30 - Comparison of results for tests MILL11, MILL12, MILL13, MILL14 and MILL02

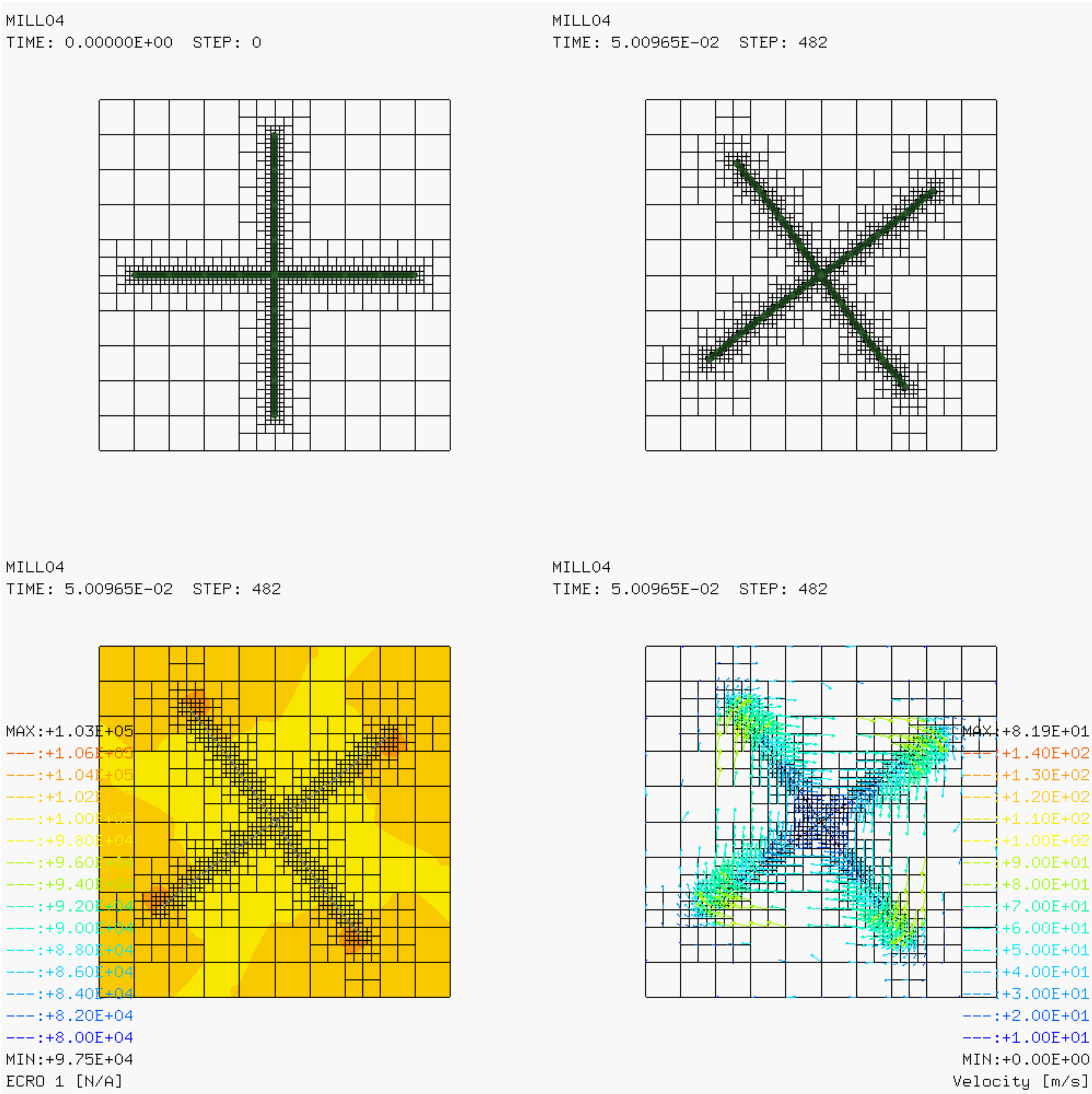
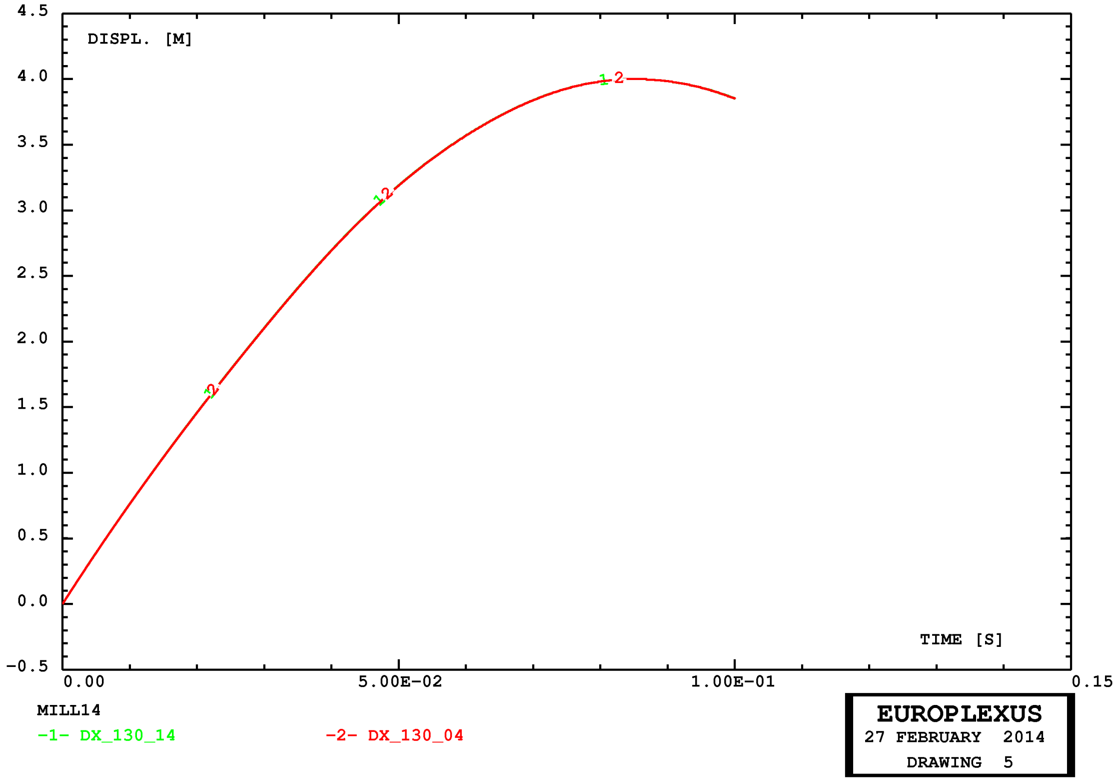


Figure 31 - Some results for test MILL04



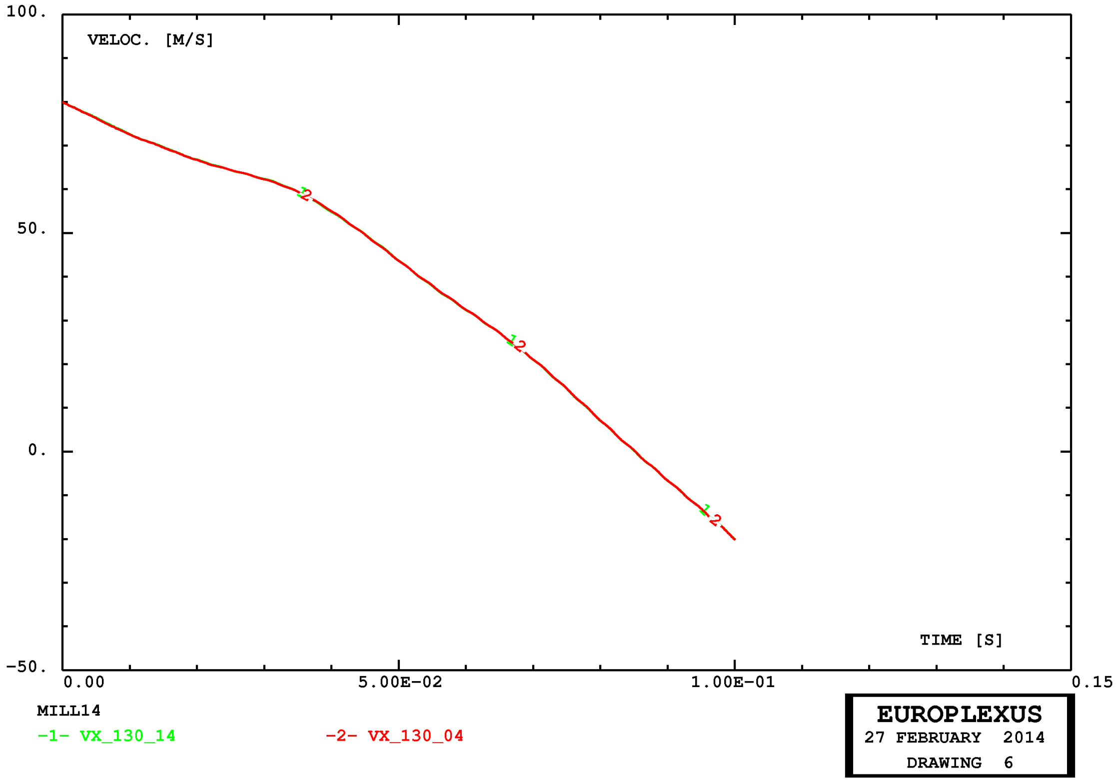


Figure 32 - Comparison of results for tests MILL14 and MILL04

4. Numerical examples with CCFV

We consider now the same numerical examples as in the previous Section, but by using a CCFV discretization of the fluid sub-domain instead of a FE discretization. The `FLSW` coupling directive is therefore used and tested, instead of `FLSR`.

4.1 Flying plate in 2D

The problem has been already defined in Section 3.1, see Figure 3. Here the same calculations are repeated by using the CCFV element Q4VF instead of FL24, and the `LINK DECO FLSW` coupling directive instead of `LINK COUP FLSR`. The parameter `FACE` is added to the FLSW directive. This optional keyword is only available with `FLSW` (not with `FLSR`) and searches directly for the coupled CCFV interfaces, rather than for the coupled volume centroids.

No options are specified for the CCFV, so the default options are taken: second-order without reconstruction (i.e. first-order) solution, HLLC flux solver, etc.

First, a reference solution is obtained by means of non-adaptive calculations with more and more refined fluid meshes. Then, adaptive calculations are tested. All performed calculations are summarized in Table 4.

Case	Fluid Mesh	Notes	Steps	CPU [s]	Els*step
FSIA21	100 Q4VF	No adaptivity	961	0.6	102,934
FSIA22	400 Q4VF	No adaptivity	961	1.1	391,534
FSIA23	1,600 Q4VF	No adaptivity	961	3.7	1,545,934
FSIA24	6,400 Q4VF	No adaptivity	1,026	17.2	6,579,989
FSIA16	base: 100 Q4VF	ADAP LMAX 3, RCON	961	1.3	220,075
FSIA19	base: 100 Q4VF	ADAP LMAX 4, RCON	961	2.1	394,000
FSIA20	base: 100 Q4VF	ADAP LMAX 4 SCAL 2	961	3.1	554,482

Table 4 - Calculations for the FSIA problem with CCFV in the fluid domain

4.1.1 Solutions without mesh adaptivity

FSIA21

This test uses a very coarse fluid mesh, of just 10×10 Q4VF quadrilateral fluid elements. The initial FLSW structural domains and coupled fluid nodes are shown in the first part of Figure 33. Then are shown the same quantities, the pressure field and the velocity field at 50 ms (half of the transient calculation) when the fluid flow is already well-developed.

FSIA22

This test is similar to the previous one but uses a more refined fluid mesh, of 20×20 Q4VF quadrilaterals. Some results of this test are shown in Figure 34.

FSIA23

This test is similar to the previous one but uses a more refined fluid mesh, of 40×40 Q4VF quadrilaterals. Some results of this test are shown in Figure 35.

FSIA24

This test is similar to the previous one but uses a more refined fluid mesh, of 80×80 Q4VF quadrilaterals. Some results of this test are shown in Figure 36.

Figure 37 compares results of all four calculations, showing the displacement and velocity of a node near the center of the plate. It can be seen that, apart the coarsest-mesh case (FSIA21), the solution is only slightly sensitive to fluid mesh fineness, if one considers only the plate motion. However, we will assume as reference the solution with the finest mesh (FSIA24), i.e. the green curves in Figure 37.

4.1.2 Solutions with mesh adaptivity

FSIA16

This test uses a base fluid mesh of 10×10 Q4VF quadrilateral fluid elements, exactly like in case FSIA21. However, in the FLSW directive we specify `ADAP LMAX 3`, i.e. adaptive refinement near the structure up to a level 3 (thus a refinement of up to a factor 4 with respect to the base mesh), which would correspond to a fluid mesh of the same size as case FSIA23. Some results of this test are shown in Figure 38.

In this case use has been made of the `OPTI ADAP RCON` option in order to keep the adapted mesh always graded. Without this option, the jump in mesh size between two neighboring fluid elements was more than 2, in some cases. Despite use of the option, no ping-pong effects were detected by the dedicated check.

The solution is similar to the one of case FSIA23, although the base mesh is the one with only 10×10 elements, which is too coarse (since in the preliminary study the solution with this mesh was quite bad). Probably, a better choice would be that of using at least a 20×20 base mesh (like in case FSIA12). This would substantially improve the result in the non-refined zones of the mesh with only a very marginal increase of CPU time.

Note that in this calculation the user specifies the FLSW directive e*xactly like in the case without adaptivity* (apart from the additional `ADAP LMAX` keyword). In other words, we use an FLSW radius

$R = 0.7072$ (for a square base mesh of size 1.0), the same as in case FSIA21, while in the case FSIA23 (without adaptivity) we had to specify $R = 0.1768$, i.e $1/4$ of the previous value.

FSIA19

This test is similar to FSIA16 but in the FLSW directive we specify `ADAP LMAX 4`, i.e. adaptive refinement near the structure up to a level 4 (thus a refinement of up to a factor 8 with respect to the base mesh), which would correspond to a fluid mesh of the same size as case FSIA24. Some results of this test are shown in Figure 39.

Again, we specify an FLSW radius $R = 0.7072$ (for a square base mesh of size 1.0), the same as in case FSIA21, because this is the value related to the *base* fluid mesh.

This solution is very similar to FSIA16, the main difference being due to the better resolution in the zones above and below the plate (which are meshed too coarsely in the first case). It should be noted that the CPU time required for a level-4 locally adaptive calculation is less than twice the one needed for the corresponding level-3 calculation. With the same two mesh sizes, not only are the non-adaptive calculations more expensive in absolute terms, but the ratio of CPU times in that case is more than 4.

In other words, uniform-mesh calculations rapidly become impossible due to excessive CPU time as the mesh size is reduced, while locally adaptive ones remain affordable even at very fine local mesh (which is needed to have good accuracy of the FSI algorithm).

A comparison of all 6 calculations (4 without and 2 with adaptivity) is given in Figure 40 in terms of plate displacement and velocity. The finest-mesh solutions FSIA24 and FSIA19 are very similar. They are compared alone in Figure 41 for clarity.

Finally, Figure 42 compares the solutions FSIA14 and FSIA24, i.e. the non-adaptive and adaptive solutions with the finest meshes.

FSIA20

This test is similar to FSIA19 but does not use the `OPTI ADAP RCON` option and a `SCAL 2.0` optional parameter in the `FLSW` directive instead.

Some results for this test are presented in Figure 43. Note how the adapted fluid mesh remains naturally graded despite the lack of the `ADAP RCON` option. The number of elements and nodes to be allocated in the adaptive process is larger than in case FSIA19, but this is normal since the refined zone is larger. However, the number of fluid interfaces interacting with the structure, and thus the mass of fluid “attached” to the structure, is exactly the same in the two cases. This solution is similar to FSIA19.

The finest-mesh solutions FSIA14 and FSIA20 are reasonably similar. They are compared in Figure 44.

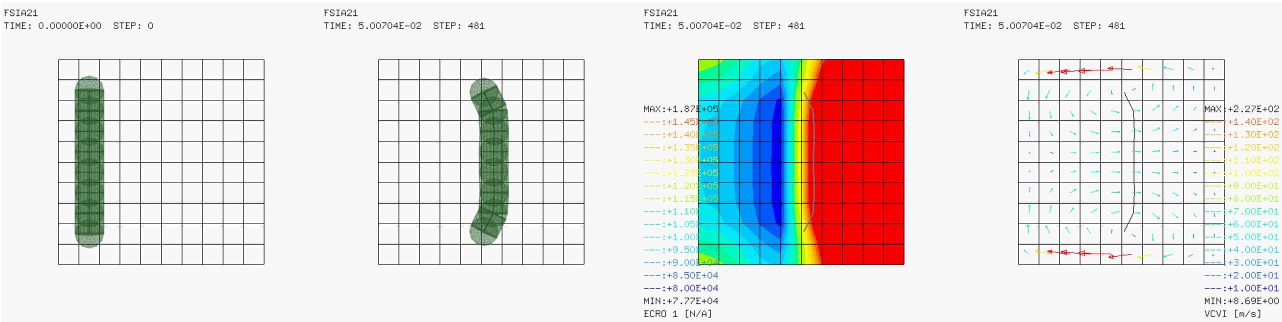


Figure 33 - Some results for test FSIA21

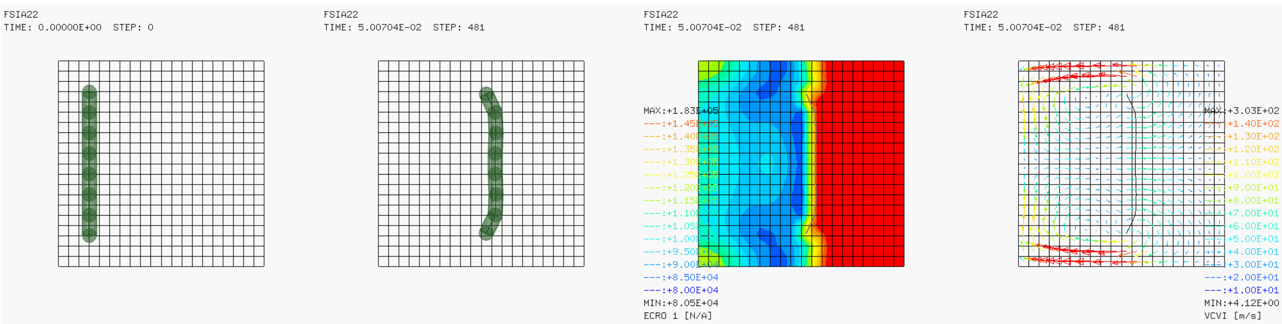


Figure 34 - Some results for test FSIA22

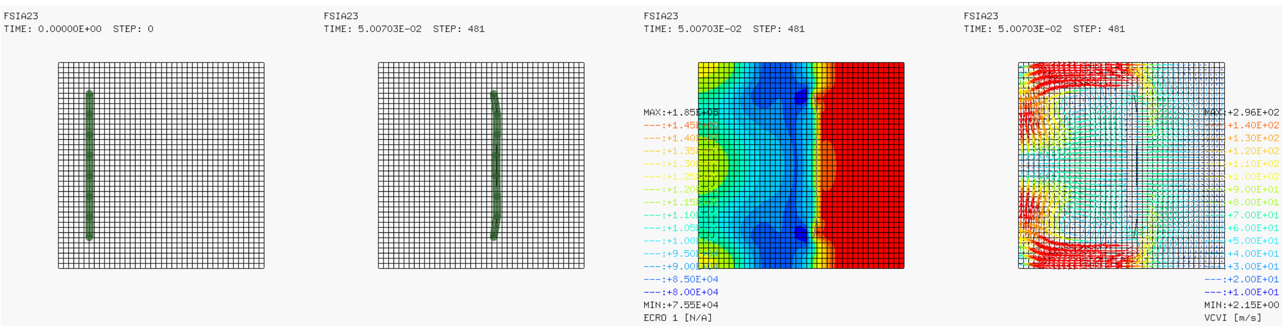


Figure 35 - Some results for test FSIA23

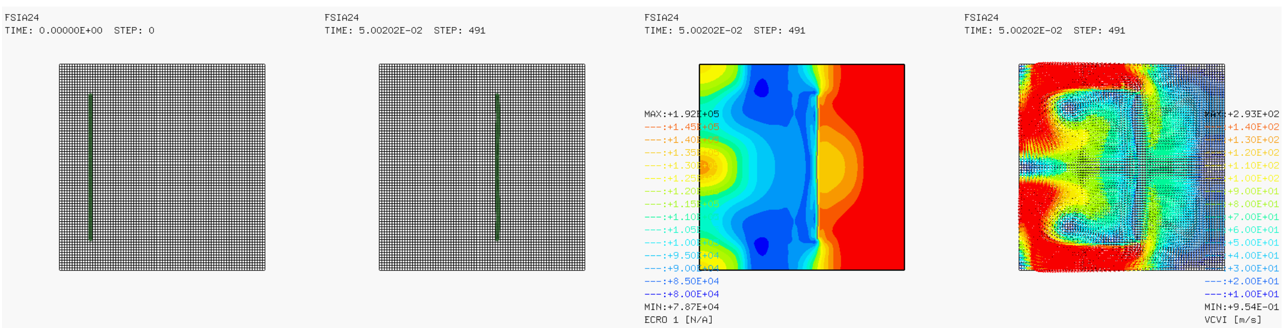
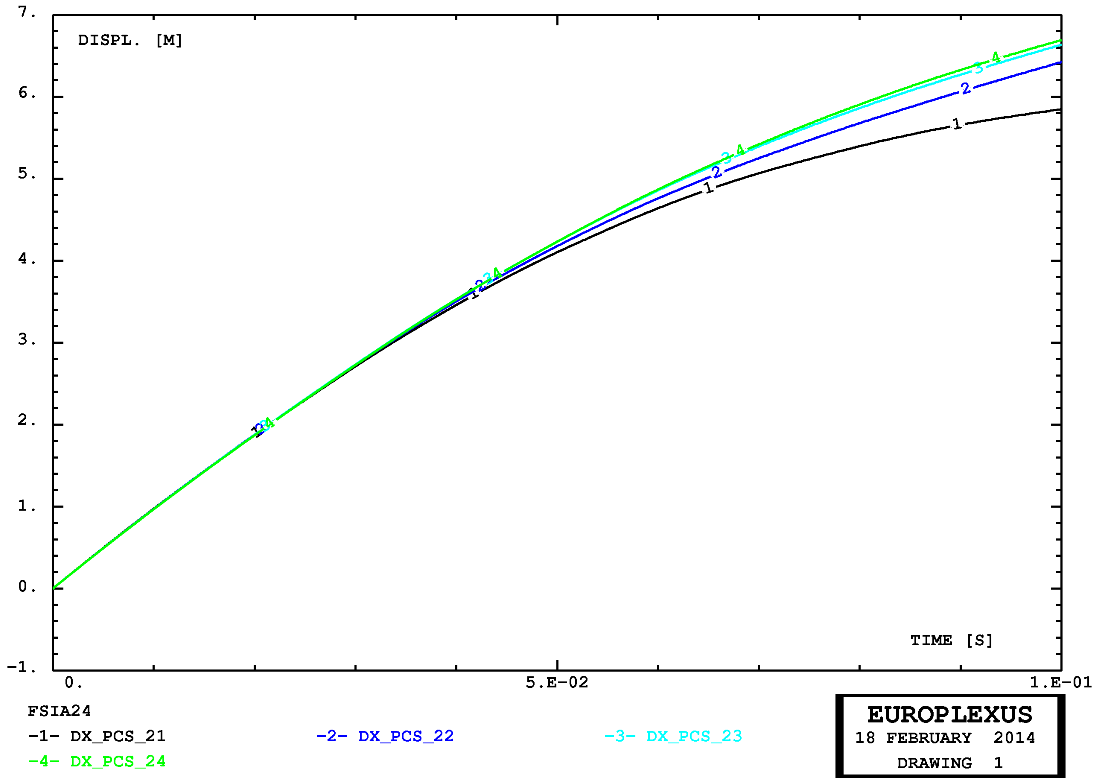


Figure 36 - Some results for test FSIA24



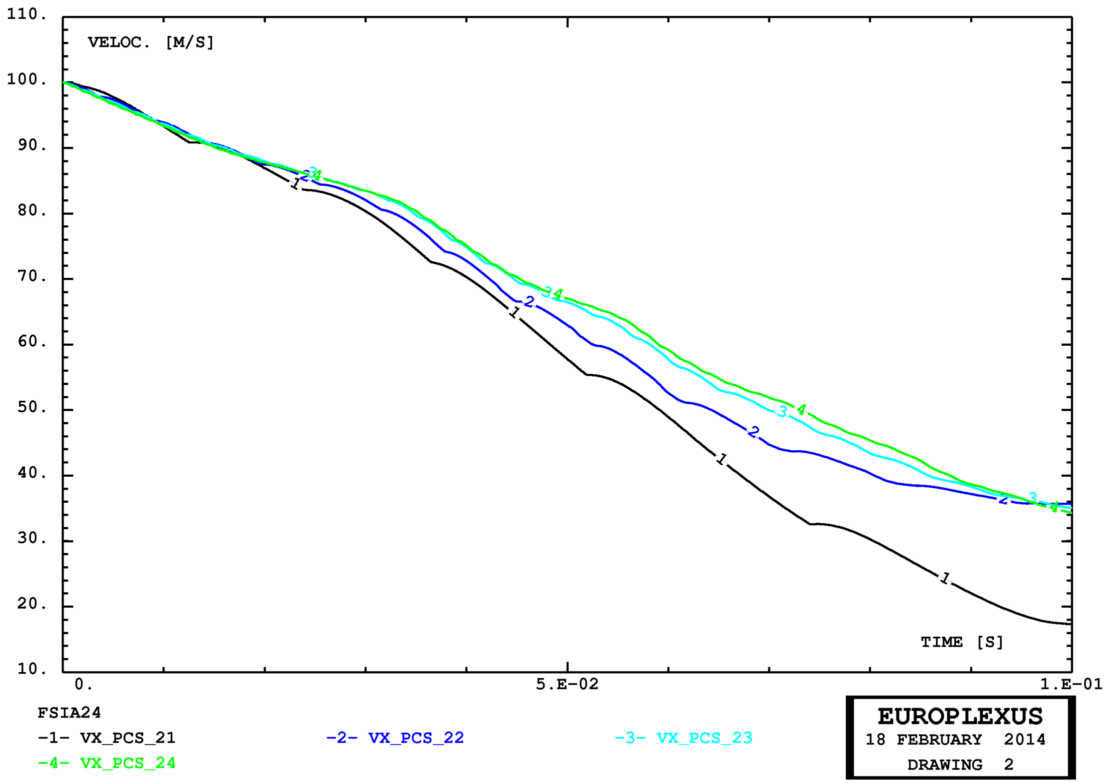


Figure 37 - Comparison of results for tests FSIA21, FSIA22, FSIA23 and FSIA24

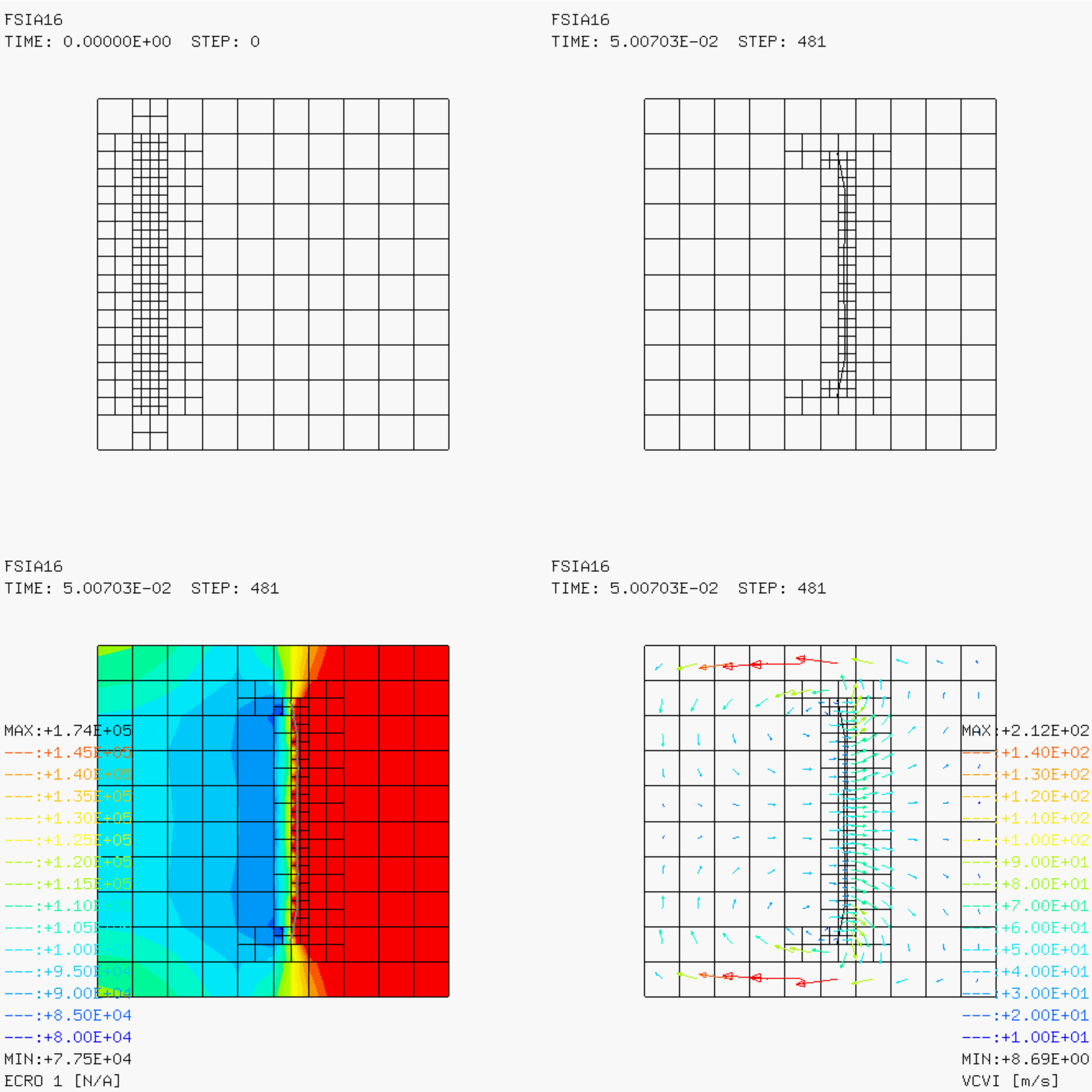


Figure 38 - Some results for test FSIA16

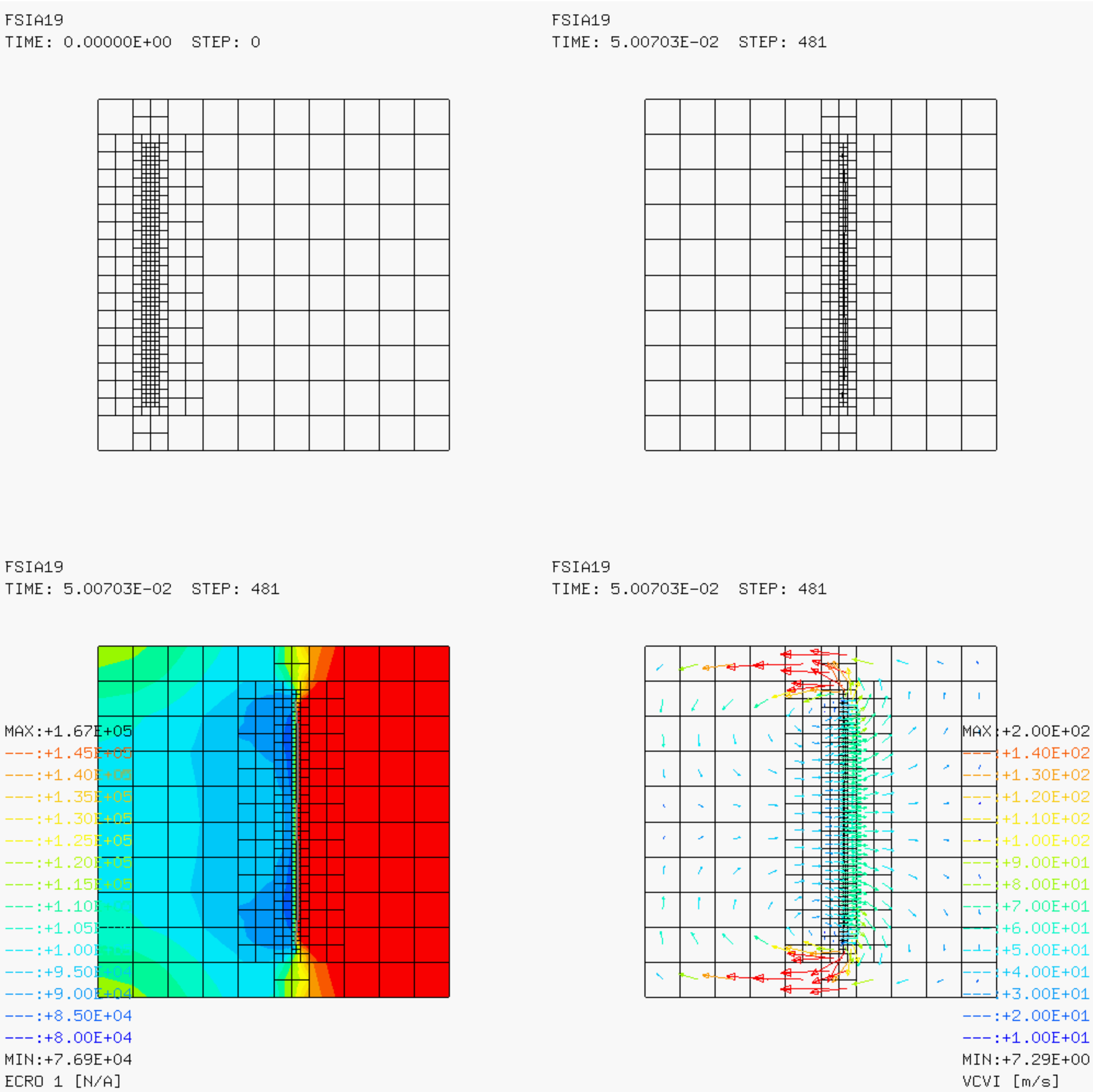
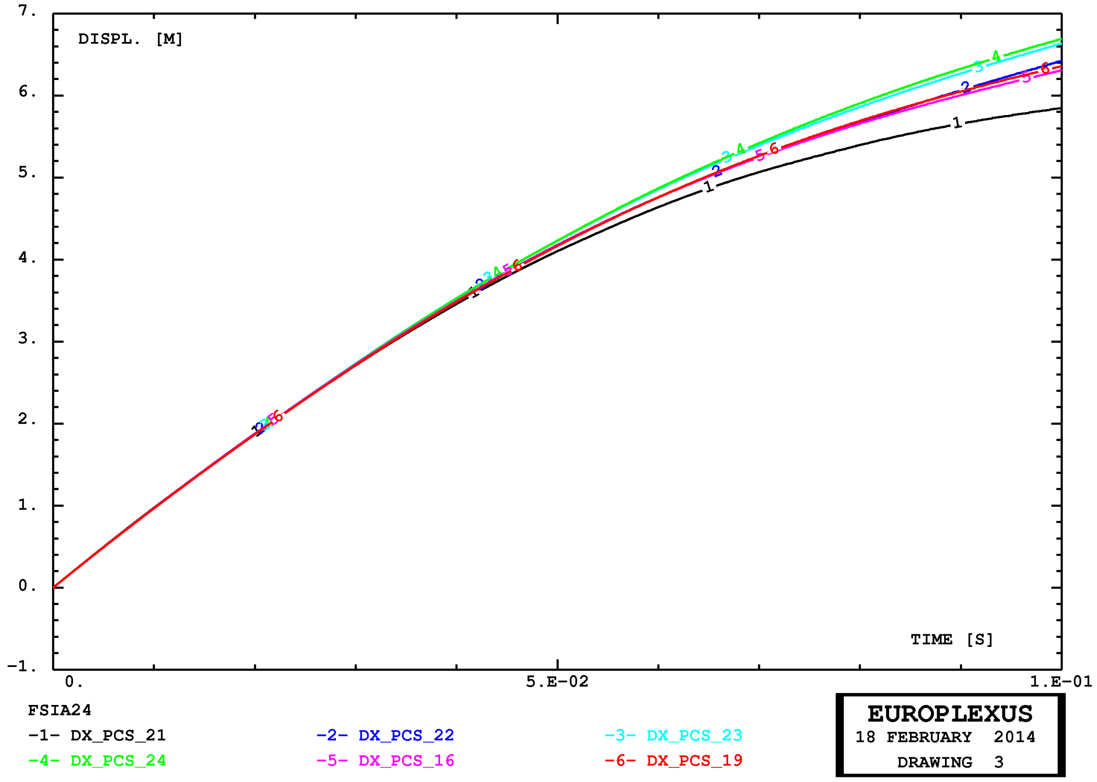


Figure 39 - Some results for test FSIA19



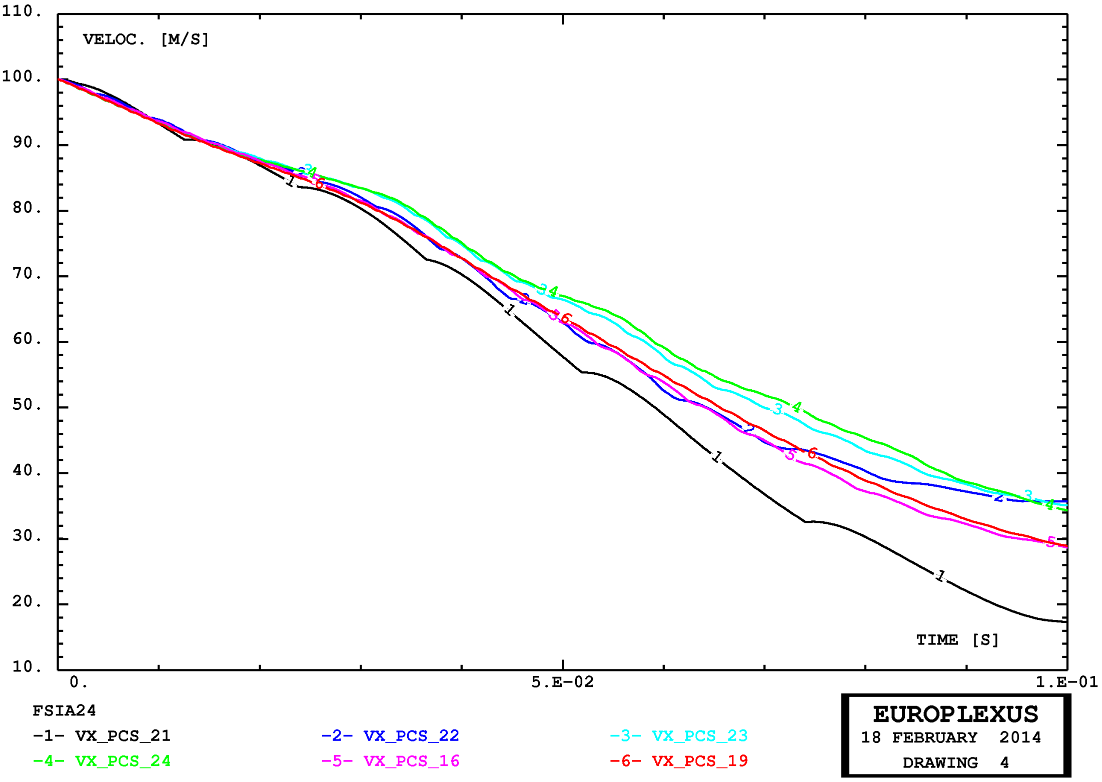
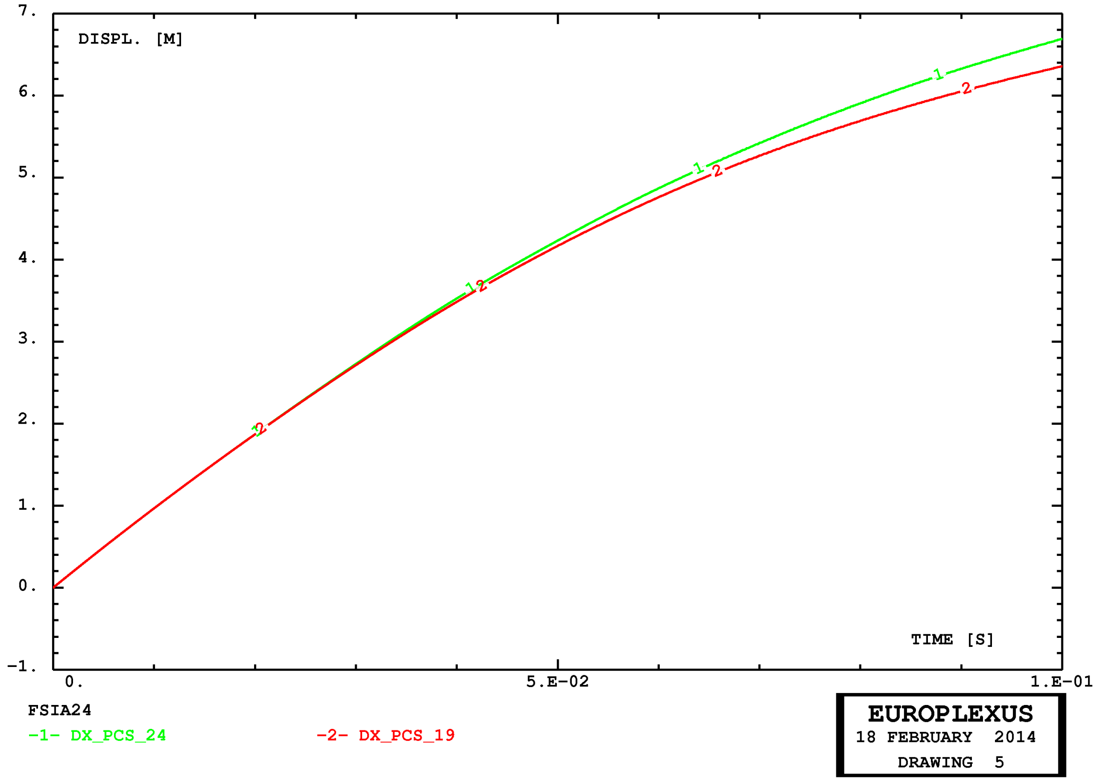


Figure 40 - Comparison of results for tests FSIA21, FSIA22, FSIA23, FSIA24, FSIA16 and FSI19



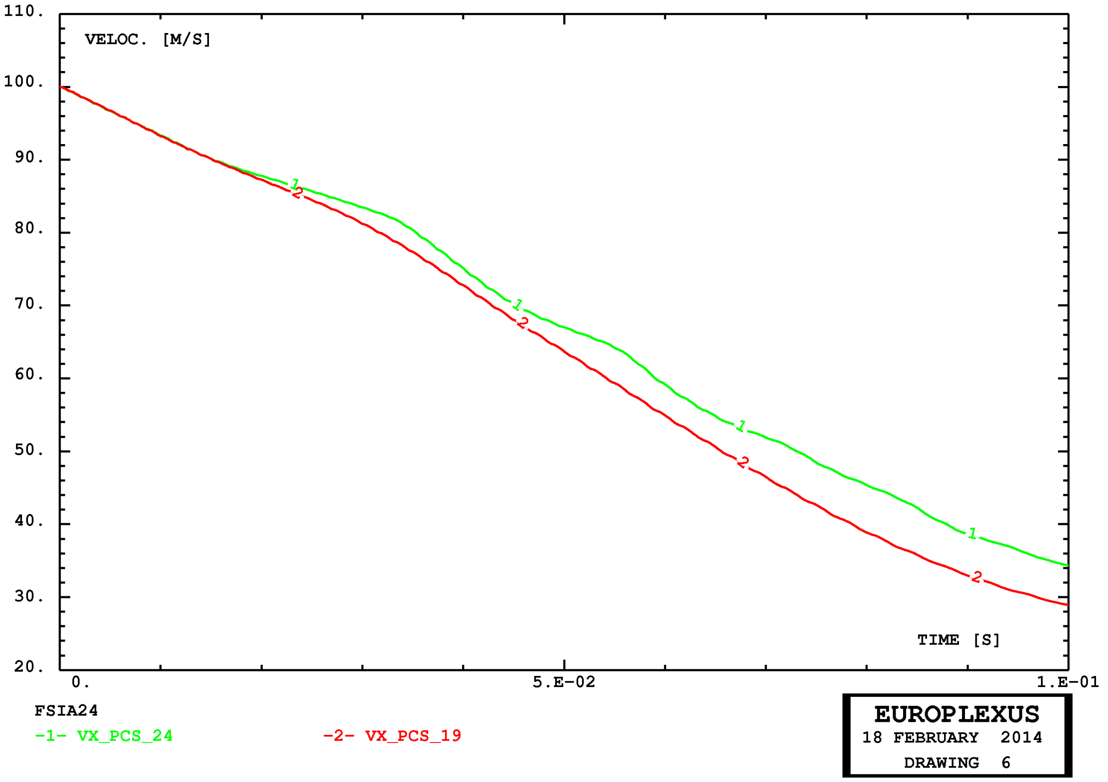
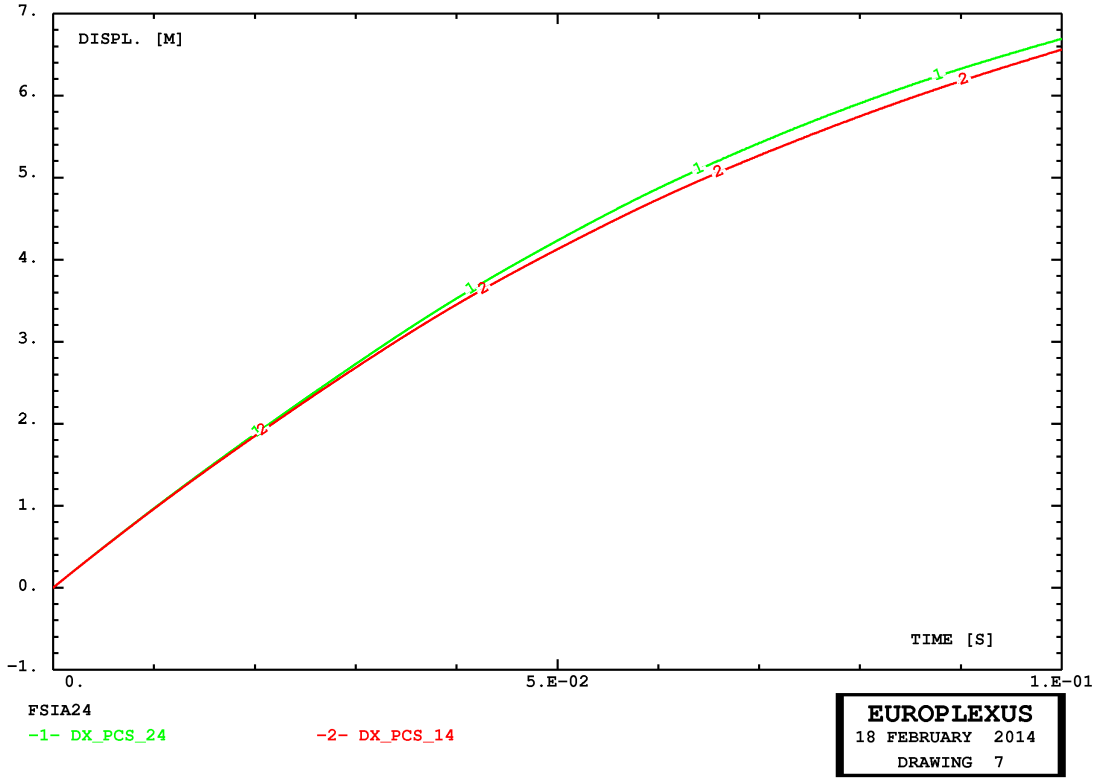


Figure 41 - Comparison of results for tests FSIA14 and FSIA09



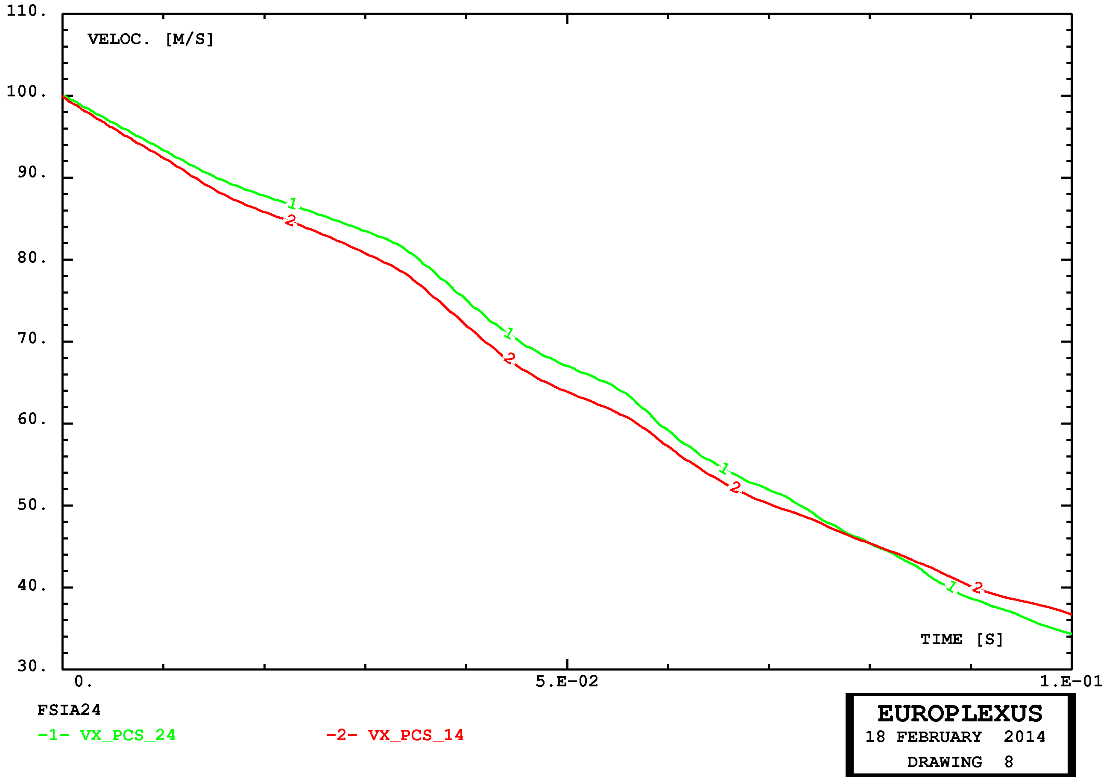


Figure 42 - Comparison of results for tests FSIA14 and FSIA24

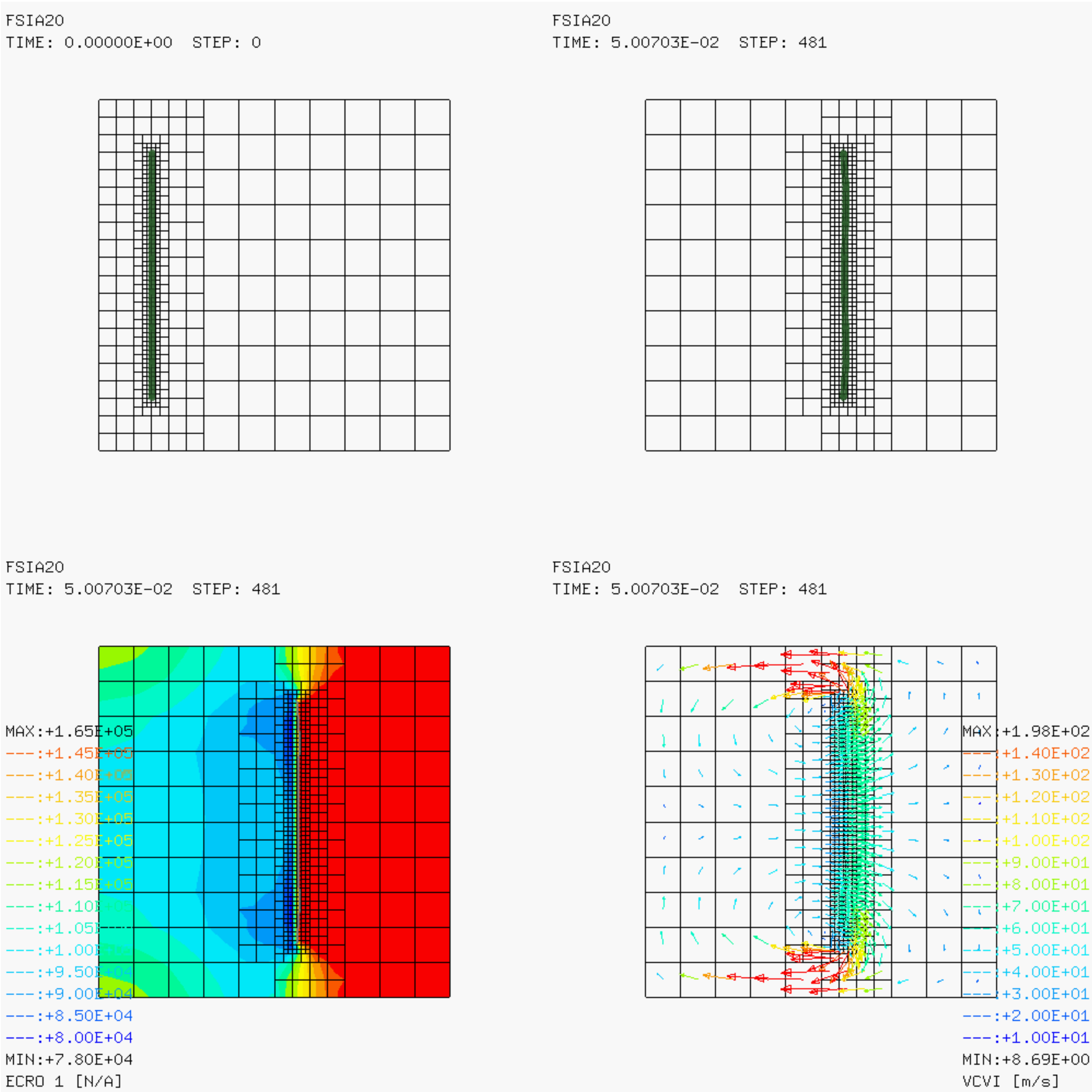
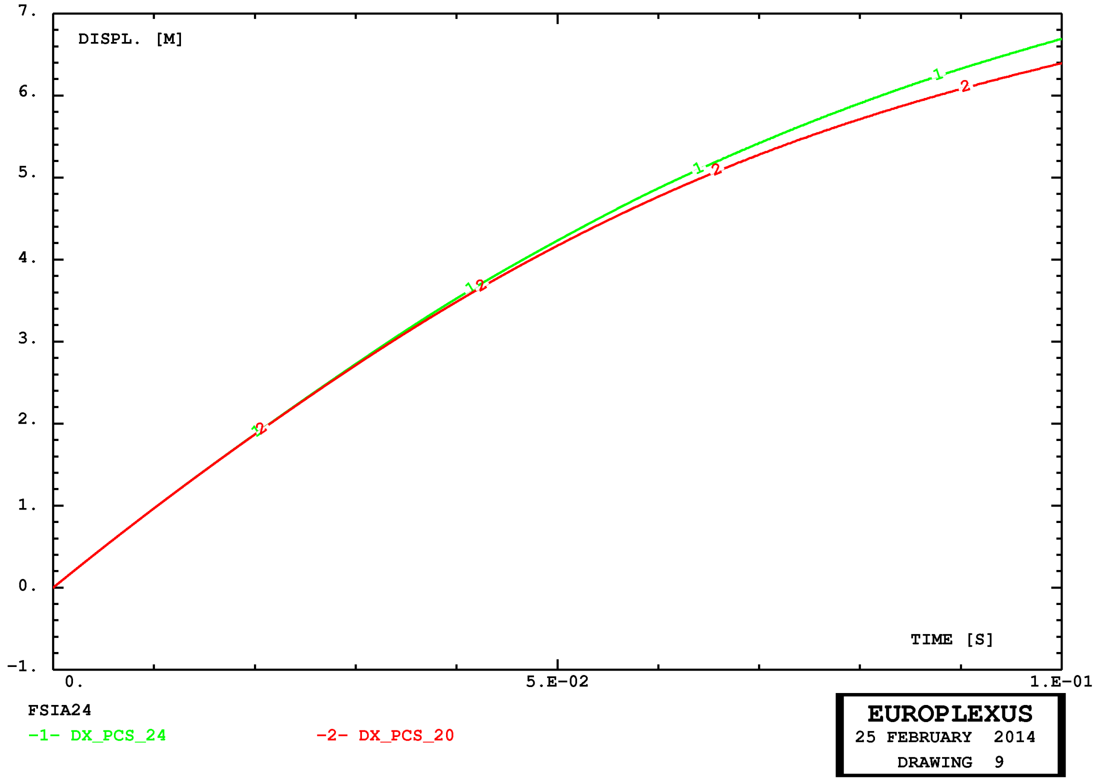


Figure 43 - Some results for test FSIA20



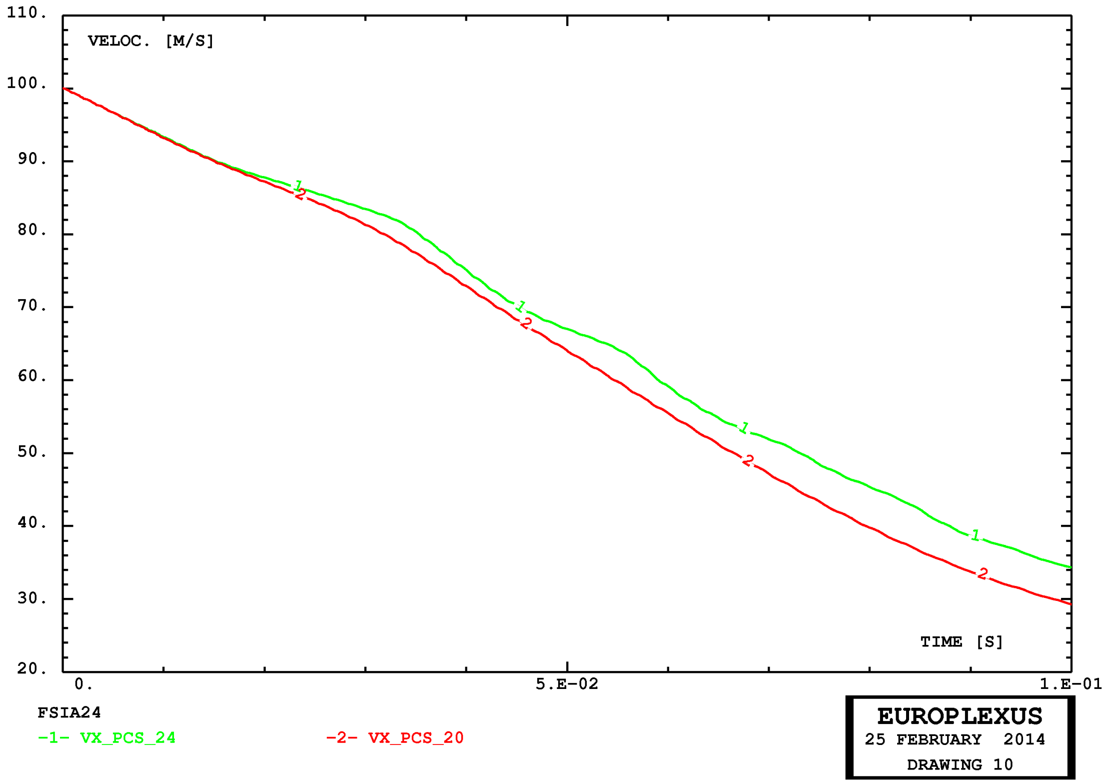


Figure 44 - Comparison of results for tests FSIA20 and FSIA24

4.2 Flying plate in 3D

The problem has been already defined in Section 3.2, see Figure 15. Here the same calculations are repeated by using the CCFV element CUVF instead of FL38, and the `LINK DECO FLSW` coupling directive instead of `LINK COUP FLSR`. The parameter `FACE` is added to the FLSW directive. This optional keyword is only available with `FLSW` (not with `FLSR`) and searches directly for the coupled CCFV interfaces, rather than for the coupled volume centroids.

No options are specified for the CCFV, so the default options are taken: second-order without reconstruction (i.e. first-order) solution, HLLC flux solver, etc.

First, a reference solution is obtained by means of non-adaptive calculations with more and more refined fluid meshes. Then, adaptive calculations are tested. All performed calculations are summarized in Table 5.

Case	Fluid Mesh	Notes	Steps	CPU [s]	Els*step
FSIA41	1,000 CUVF	No adaptivity	963	5.6	1,011,236
FSIA42	8,000 CUVF	No adaptivity	963	32.3	7,759,236
FSIA43	64,000 CUVF	No adaptivity	962	243.2	61,679,187
FSIA36	base: 1,000 CUVF	ADAP LMAX 3	962	78.0	5,175,299

Table 5 - Calculations for the FSIA problem in 3D with CCFV in the fluid domain

4.2.1 Solutions without mesh adaptivity

FSIA41

This test uses a very coarse fluid mesh, of just $10 \times 10 \times 10$ CUVF hexahedral fluid elements. The initial FLSW structural domains and coupled fluid nodes are shown in the first part of Figure 45. Then are shown the same quantities, the pressure field and the velocity field at 50 ms (half of the transient calculation) when the fluid flow is already well-developed.

FSIA42

This test is similar to the previous one but uses a more refined fluid mesh, of $20 \times 20 \times 20$ CUVF hexahedra. Some results of this test are shown in Figure 46.

FSIA43

This test is similar to the previous one but uses a more refined fluid mesh, of $40 \times 40 \times 40$ CUVF hexahedra. Some results of this test are shown in Figure 47.

Figure 48 compares results of all three calculations, showing the displacement and velocity of a node near the center of the plate. It can be seen that in this case the solution converges less clearly than in the similar calculations with FE. Nevertheless, we will assume as reference the solution with the finest mesh (FSIA43), i.e. the cyan curves in Figure 48.

4.2.2 Solutions with mesh adaptivity

FSIA36

This test uses a base fluid mesh of $10 \times 10 \times 10$ CUVF hexahedral fluid elements, exactly like in case FSIA41. However, in the FLSW directive we specify `ADAP LMAX 3`, i.e. adaptive refinement near the structure up to a level 3 (thus a refinement of up to a factor 4 with respect to the base mesh), which would correspond to a fluid mesh of the same size as case FSIA43. Some results of this test are shown in Figure 49.

In this case use has been made of the `OPTI ADAP RCON` option. Despite use of the option, no ping-pong effects were detected by the dedicated check.

The solution is similar to the one of case FSIA43, but even more to that of case FSIA42, which corresponds to a refinement of level 2 instead of 3.

A comparison of all 4 calculations (3 without and 1 with adaptivity) is given in Figure 50 in terms of plate displacement and velocity. The finest-mesh solutions FSIA43 and FSIA36 are relatively similar. They are compared alone in Figure 51 for clarity.

As can be seen from Table 5, with CCFV and FLSW (weak or decoupled links) the speed-up factor between the calculations without and with adaptivity is 3.1 (greater than 1, unlike in the case with FE and FLSR).

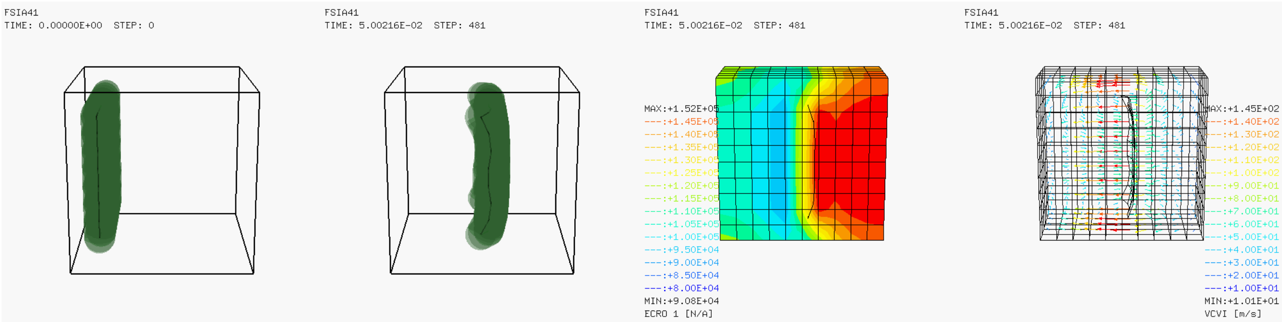


Figure 45 - Some results for test FSIA41

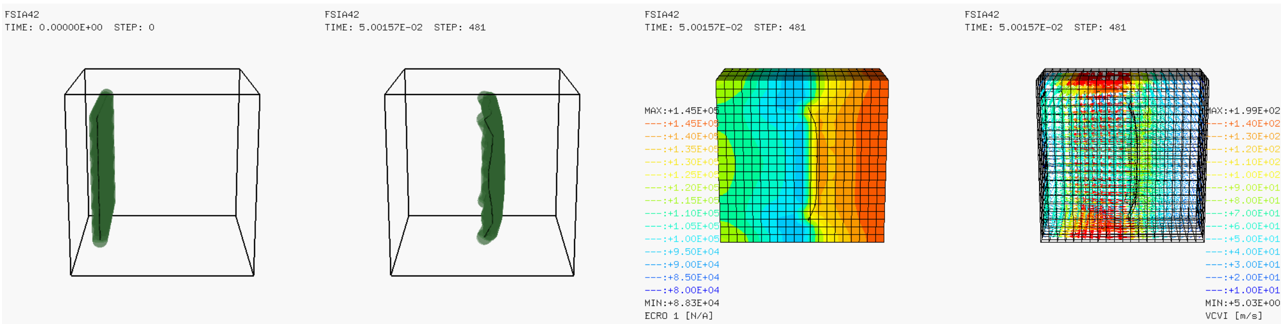


Figure 46 - Some results for test FSIA42

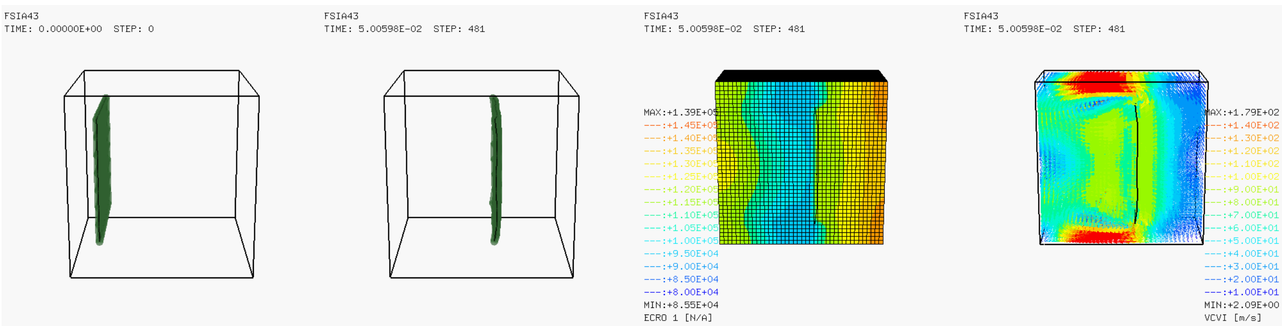
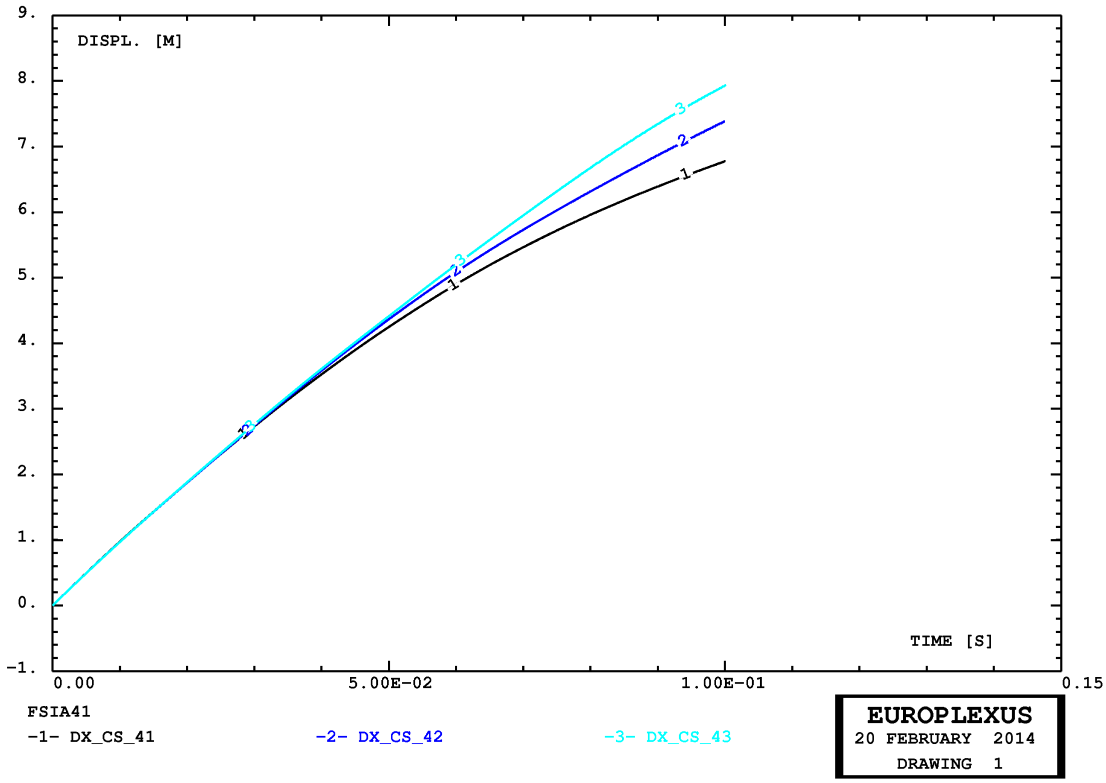


Figure 47 - Some results for test FSIA43



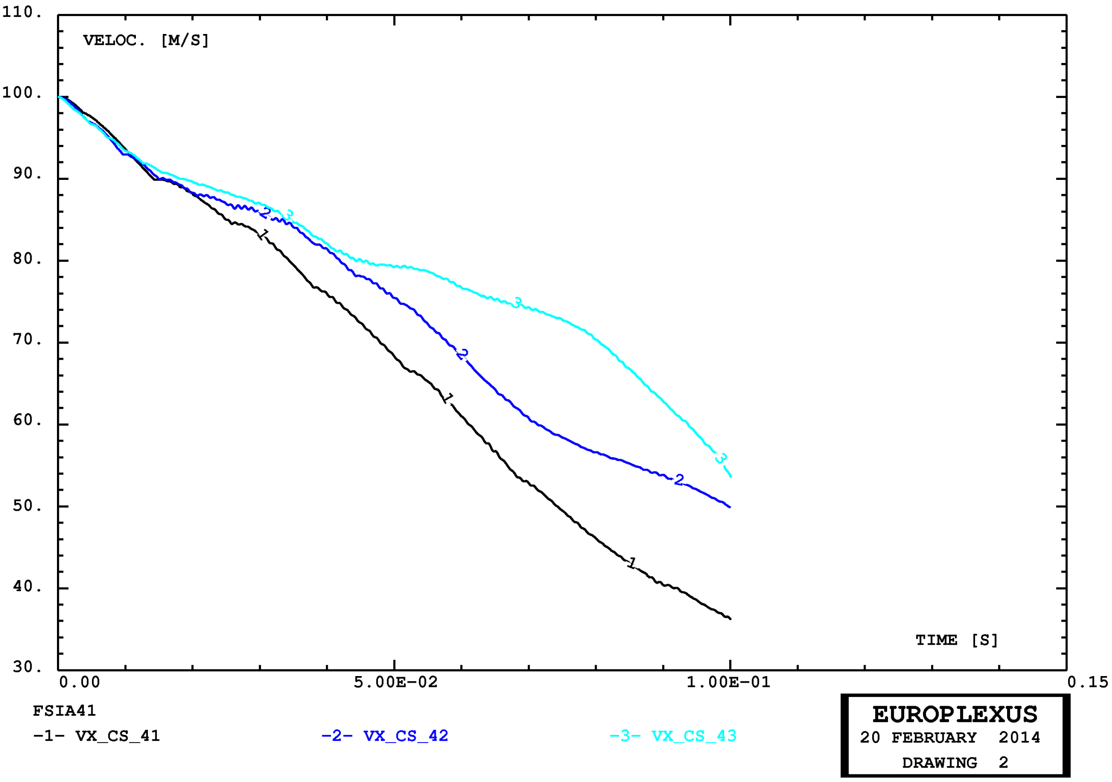


Figure 48 - Comparison of results for tests FSIA41, FSIA42 and FSIA43

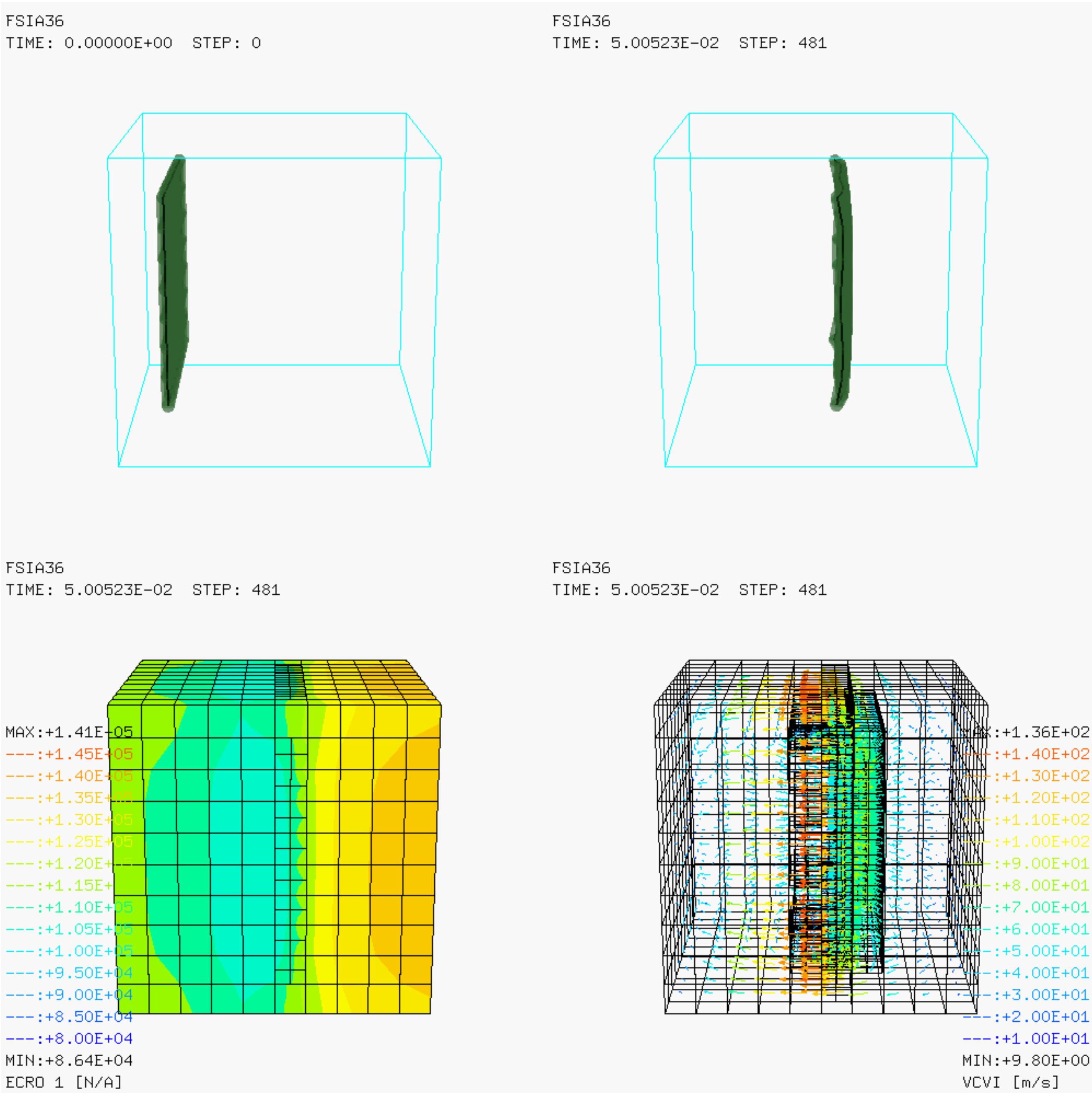
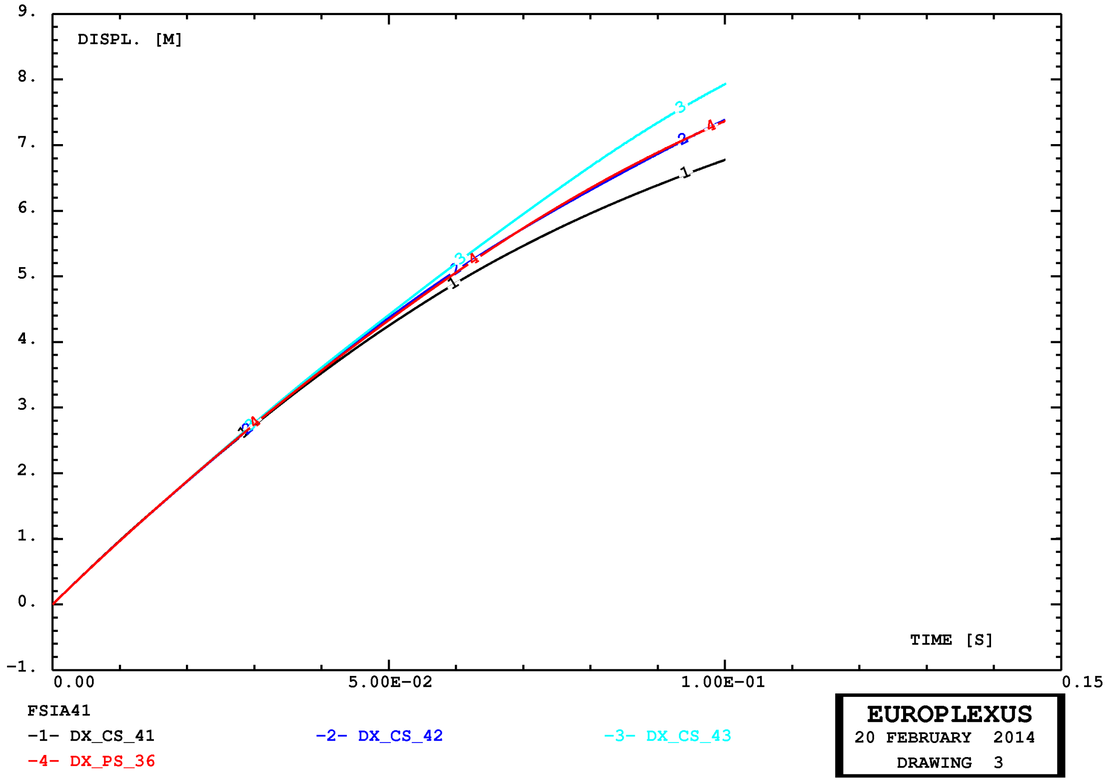


Figure 49 - Some results for test FSIA36



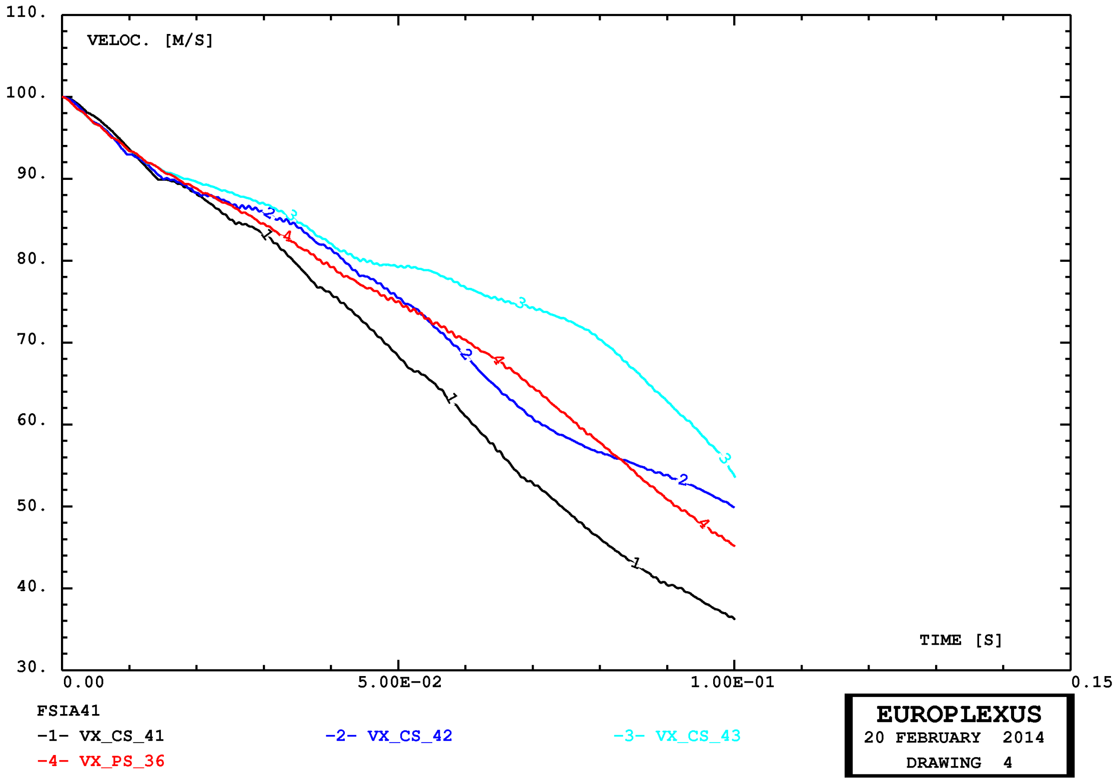
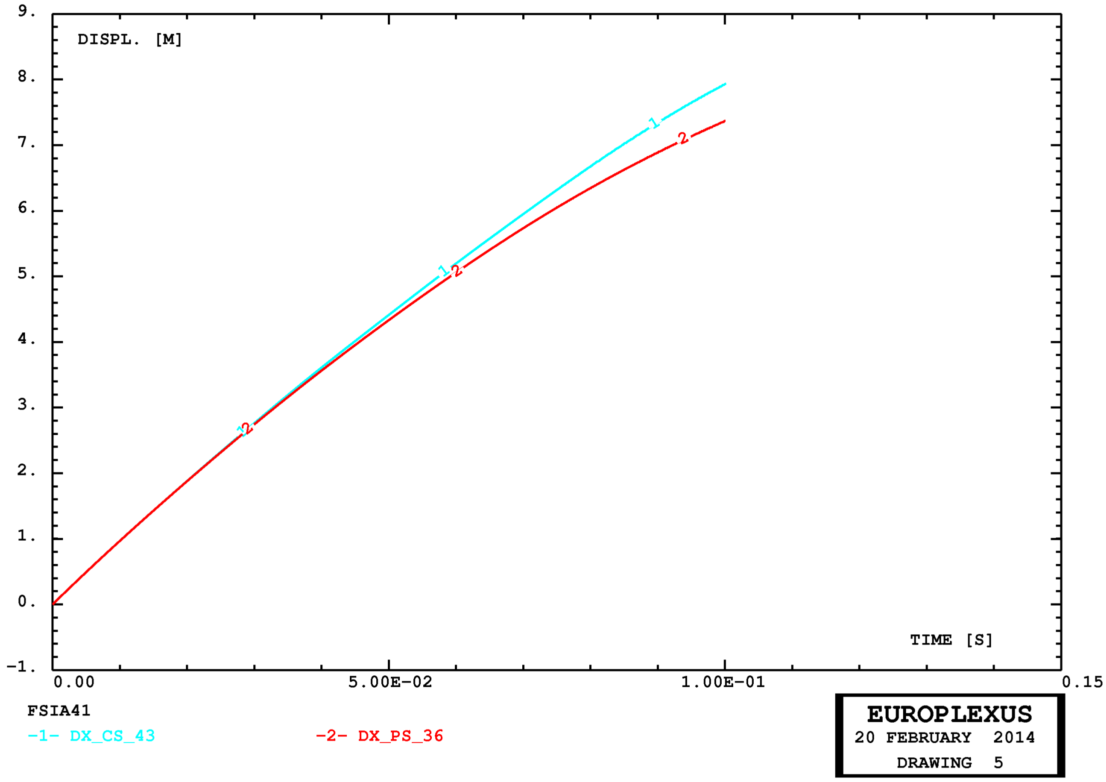


Figure 50 - Comparison of results for tests FSIA41, FSIA42, FSIA43 and FSIA46



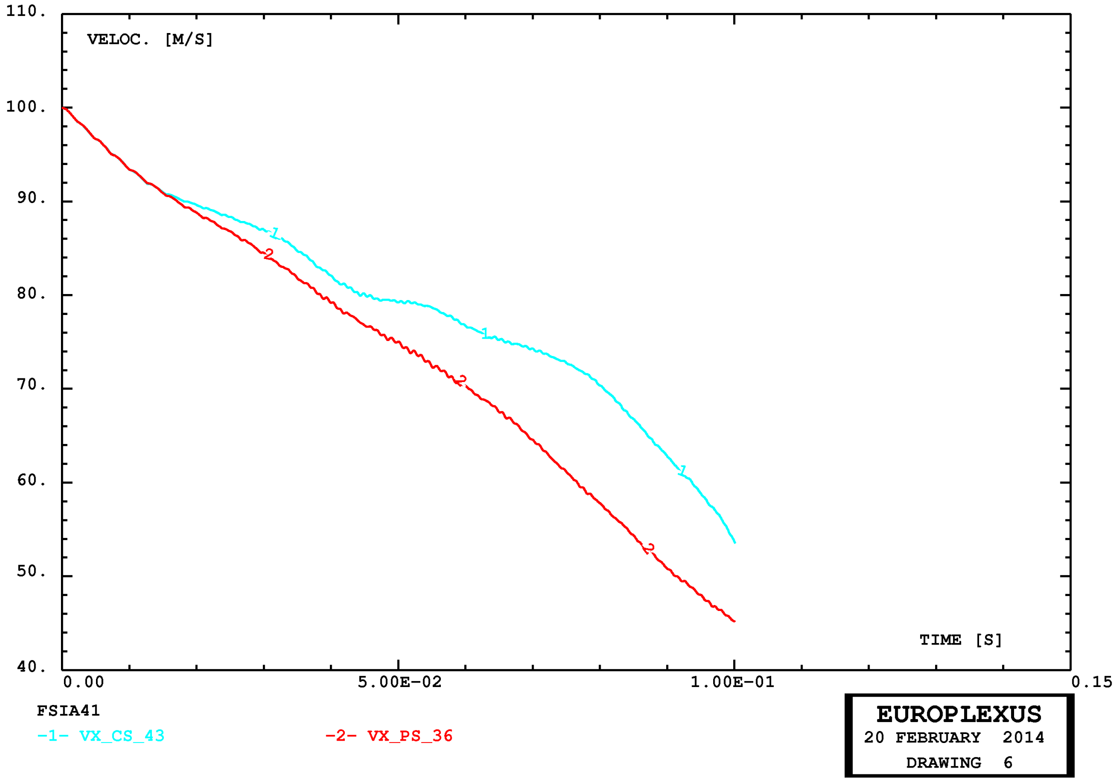


Figure 51 - Comparison of results for tests FSIA43 and FSIA36

5. Conclusions

In this report the automatic adaptation (refinement, un-refinement) of fluid mesh in the vicinity of a moving structure has been presented. The adapted fluid mesh interacts with the structure by means of so-called embedded FSI algorithms, namely the FLSR (strong coupling by means of Lagrange multipliers) and the FLSW (weak coupling by means of direct pressure force transmission) algorithms.

The implementation is done in 2D and 3D and covers Finite Element as well as Cell Centred Finite Volume discretizations of the fluid domain. The input directives are very simple and various levels of refinement (`LMAX`) can be tested by changing a single value in the input file.

The numerical examples show that the technique allows calculations with locally fine fluid mesh with just a fraction of the memory (number of elements) that would be required with a uniformly refined fluid mesh.

As concerns CPU times, a gain may or may not be obtained depending on circumstances. When using the strong version of FSI (i.e. the "coupled" version of the FLSR algorithm, suitable for FE), the calculation time is sometimes penalized by the large number of constraints and by the solution of the system to obtain the Lagrange multipliers (the interaction forces). The chosen adaptive scheme adds constraints at hanging nodes, which must be combined with FSI-related and other constraints.

With the weak version of FSI (i.e. the FLSW algorithm, suitable for CCFV) there are two advantages. First, no constraints are required for the FSI, by definition. But also no constraints are required at hanging nodes in this case, because the fluid velocities are discretized at cell centres, not at nodes. Therefore, a calculation of this type can be done without any (coupled) constraints, resulting often in a larger gain than in the previous case.

A version of FLSR not using Lagrange multipliers (the so-called LINK DECO FLSR model) is also available in the code. This might be an interesting alternative allowing to obtain larger CPU gains in combination with FE descriptions of the fluid domain. However, the combination of adaptivity with this FSI model is not yet complete and will be finalized in a forthcoming report.

6. References

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Appendix

Sample input files

This Section contains, in alphabetical file order, the listings of all input files related to the examples which were proposed in the previous Sections.

fsia06.epx

```
FSIA06
ECHO
!CONV win
DPLA ALE
DIME
  ADAP NPOI 205 FL24 232 ENDA
  NALE 1 NBLE 1
TERM
GEOM LIBR POIN 129 FL24 100 ED01 7 TERM
 0 0  1 0  2 0  3 0  4 0  5 0  6 0  7 0  8 0  9 0  10 0
 0 1  1 1  2 1  3 1  4 1  5 1  6 1  7 1  8 1  9 1  10 1
 0 2  1 2  2 2  3 2  4 2  5 2  6 2  7 2  8 2  9 2  10 2
 0 3  1 3  2 3  3 3  4 3  5 3  6 3  7 3  8 3  9 3  10 3
 0 4  1 4  2 4  3 4  4 4  5 4  6 4  7 4  8 4  9 4  10 4
 0 5  1 5  2 5  3 5  4 5  5 5  6 5  7 5  8 5  9 5  10 5
 0 6  1 6  2 6  3 6  4 6  5 6  6 6  7 6  8 6  9 6  10 6
 0 7  1 7  2 7  3 7  4 7  5 7  6 7  7 7  8 7  9 7  10 7
 0 8  1 8  2 8  3 8  4 8  5 8  6 8  7 8  8 8  9 8  10 8
 0 9  1 9  2 9  3 9  4 9  5 9  6 9  7 9  8 9  9 9  10 9
 0 10  1 10  2 10  3 10  4 10  5 10  6 10  7 10  8 10  9 10  10 10
 1.5 1.5  1.5 2.5  1.5 3.5  1.5 4.5
 1.5 5.5  1.5 6.5  1.5 7.5  1.5 8.5
 1 2 13 12   2 3 14 13   3 4 15 14   4 5 16 15   5 6 17 16
 6 7 18 17   7 8 19 18   8 9 20 19   9 10 21 20  10 11 22 21
 12 13 24 23 13 14 25 24 14 15 26 25 15 16 27 26 16 17 28 27
 17 18 29 28 18 19 30 29 19 20 31 30 20 21 32 31 21 22 33 32
 23 24 35 34 24 25 36 35 25 26 37 36 26 27 38 37 27 28 39 38
 28 29 40 39 29 30 41 40 30 31 42 41 31 32 43 42 32 33 44 43
 34 35 46 45 35 36 47 46 36 37 48 47 37 38 49 48 38 39 50 49
 39 40 51 50 40 41 52 51 41 42 53 52 42 43 54 53 43 44 55 54
 45 46 57 56 46 47 58 57 47 48 59 58 48 49 60 59 49 50 61 60
 50 51 62 61 51 52 63 62 52 53 64 63 53 54 65 64 54 55 66 65
 56 57 68 67 57 58 69 68 58 59 70 69 59 60 71 70 60 61 72 71
 61 62 73 72 62 63 74 73 63 64 75 74 64 65 76 75 65 66 77 76
 67 68 79 78 68 69 80 79 69 70 81 80 70 71 82 81 71 72 83 82
 72 73 84 83 73 74 85 84 74 75 86 85 75 76 87 86 76 77 88 87
 78 79 90 89 79 80 91 90 80 81 92 91 81 82 93 92 82 83 94 93
 83 84 95 94 84 85 96 95 85 86 97 96 86 87 98 97 87 88 99 98
 89 90 101 100 90 91 102 101 91 92 103 102 92 93 104 103
 93 94 105 104 94 95 106 105 95 96 107 106 96 97 108 107
 97 98 109 108 98 99 110 109
 100 101 112 111 101 102 113 112 102 103 114 113 103 104 115 114
 104 105 116 115 105 106 117 116 106 107 118 117 107 108 119 118
 108 109 120 119 109 110 121 120
 122 123  123 124  124 125  125 126  126 127
 127 128  128 129
COMP GROU 2 'flui' LECT 1 PAS 1 100 TERM
            'stru' LECT 101 PAS 1 107 TERM
     NGRO 2 'blox' LECT 1 PAS 11 111 11 PAS 11 121 TERM
            'bloy' LECT 1 PAS 1 11 111 PAS 1 121 TERM
     COUL turq LECT flui TERM
          vert LECT stru TERM
     EPAI 0.01 LECT stru TERM
GRIL LAGR LECT stru TERM
     EULE LECT flui TERM
MATE FLUT RO 1.0 EINT 2.5E5 GAMM 1.4 PB 0
          ITER 1 ALF0 1 BET0 1 KINT 0 AHGF 0 CL 0.5
          CQ 2.56 PMIN 0 NUM 1 PREF 1.E5
          LECT flui _fl24 TERM
     VM23 RO 7800. YOUNG 1.6E11 NU 0.333 ELAS 1.05E8
          TRAC 2 1.05E8 .656256E-3 1.6105E10 1.00066
          LECT stru TERM
LINK COUP
     BLOQ 1 LECT blox TERM
     BLOQ 2 LECT bloy TERM
     FLSR STRU LECT stru TERM
          FLUI LECT flui TERM
          R 0.7072 ! so that d = 2r = 1.4144
          HGRI 1.6
          DGRI
         !BFLU 0 FSCP 1
          BFLU 0 FSCP 0
          ADAP LMAX 3
INIT VITE 1 100.0 LECT stru TERM
ECRI DEPL VITE ACCE FINT FEXT TFRE 10.E-3
          POIN LECT stru TERM
          ELEM LECT stru TERM
     FICH ALIC FREQ 1 !TFRE 1.E-3
OPTI NOTE
 CSTA 0.5 LOG 1 !dpma
 LNKS STAT
 ADAP RCON
CALCUL TINI 0. TEND 100.D-3
*=================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
SCEN OBJE SELV FLSR
     GEOM NAVI FREE
     FACE HFRO
     FLSR DOMA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 962 FPS 15 KFRE 10 COMP -1 REND
FREQ 1 !FREQ 0 TFRE 1.E-3
GOTR LOOP 960 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*=================================================================
SUIT
Post-treatment
ECHO
RESU ALIC GARD PSCR
SORT GRAP
AXTE 1.0 'Time [s]'
COUR 1 'dx_pcs' DEPL COMP 1 NOEU LECT 126 TERM
COUR 2 'vx_pcs' VITE COMP 1 NOEU LECT 126 TERM
TRAC 1 AXES 1.0 'DISPL. [M]'
TRAC 2 AXES 1.0 'VELOC. [M/S]'
LIST 1 AXES 1.0 'DISPL. [M]'
LIST 2 AXES 1.0 'VELOC. [M/S]'
*=================================================================
FIN
```

fsia06p.epx

```
FSIA06P
ECHO
RESU ALIC 'fsia06.ali' GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
*=================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
SCEN GEOM NAVI FREE
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 0.8E5 PAS 0.05E5 1.45E5 TERM
          SUPP LECT flui TERM
     TEXT ISCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 962 FPS 15 KFRE 10 COMP -1 REND
FREQ 1
GOTR LOOP 960 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*=================================================================
FIN
```

fsia06v.epx

```
FSIA06V
ECHO
RESU ALIC 'fsia06.ali' GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
*=================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
SCEN GEOM NAVI FREE
     FACE HFRO
     VECT SCCO FIEL VITE SCAL USER PROG 10 PAS 10 140 TERM
     TEXT VSCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 962 FPS 15 KFRE 10 COMP -1 REND
FREQ 1
GOTR LOOP 960 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*=================================================================
FIN
```

fsia09.epx

```
FSIA09
ECHO
!CONV win
DPLA ALE
DIME
  ADAP NPOI 472 FL24 544 ENDA
  NALE 1 NBLE 1
TERM
GEOM LIBR POIN 129 FL24 100 ED01 7 TERM
 0 0  1 0  2 0  3 0  4 0  5 0  6 0  7 0  8 0  9 0  10 0
 0 1  1 1  2 1  3 1  4 1  5 1  6 1  7 1  8 1  9 1  10 1
 0 2  1 2  2 2  3 2  4 2  5 2  6 2  7 2  8 2  9 2  10 2
 0 3  1 3  2 3  3 3  4 3  5 3  6 3  7 3  8 3  9 3  10 3
 0 4  1 4  2 4  3 4  4 4  5 4  6 4  7 4  8 4  9 4  10 4
 0 5  1 5  2 5  3 5  4 5  5 5  6 5  7 5  8 5  9 5  10 5
 0 6  1 6  2 6  3 6  4 6  5 6  6 6  7 6  8 6  9 6  10 6
 0 7  1 7  2 7  3 7  4 7  5 7  6 7  7 7  8 7  9 7  10 7
 0 8  1 8  2 8  3 8  4 8  5 8  6 8  7 8  8 8  9 8  10 8
 0 9  1 9  2 9  3 9  4 9  5 9  6 9  7 9  8 9  9 9  10 9
 0 10  1 10  2 10  3 10  4 10  5 10  6 10  7 10  8 10  9 10  10 10
 1.5 1.5  1.5 2.5  1.5 3.5  1.5 4.5
 1.5 5.5  1.5 6.5  1.5 7.5  1.5 8.5
 1 2 13 12   2 3 14 13   3 4 15 14   4 5 16 15   5 6 17 16
 6 7 18 17   7 8 19 18   8 9 20 19   9 10 21 20  10 11 22 21
 12 13 24 23 13 14 25 24 14 15 26 25 15 16 27 26 16 17 28 27
 17 18 29 28 18 19 30 29 19 20 31 30 20 21 32 31 21 22 33 32
 23 24 35 34 24 25 36 35 25 26 37 36 26 27 38 37 27 28 39 38
```

```
 28 29 40 39 29 30 41 40 30 31 42 41 31 32 43 42 32 33 44 43
 34 35 46 45 35 36 47 46 36 37 48 47 37 38 49 48 38 39 50 49
 39 40 51 50 40 41 52 51 41 42 53 52 42 43 54 53 43 44 55 54
 45 46 57 56 46 47 58 57 47 48 59 58 48 49 60 59 49 50 61 60
 50 51 62 61 51 52 63 62 52 53 64 63 53 54 65 64 54 55 66 65
 56 57 68 67 57 58 69 68 58 59 70 69 59 60 71 70 60 61 72 71
 61 62 73 72 62 63 74 73 63 64 75 74 64 65 76 75 65 66 77 76
 67 68 79 78 68 69 80 79 69 70 81 80 70 71 82 81 71 72 83 82
 72 73 84 83 73 74 85 84 74 75 86 85 75 76 87 86 76 77 88 87
 78 79 90 89 79 80 91 90 80 81 92 91 81 82 93 92 82 83 94 93
 83 84 95 94 84 85 96 95 85 86 97 96 86 87 98 97 87 88 99 98
 89 90 101 100 90 91 102 101 91 92 103 102 92 93 104 103
 93 94 105 104 94 95 106 105 95 96 107 106 96 97 108 107
 97 98 109 108 98 99 110 109
 100 101 112 111 101 102 113 112 102 103 114 113 103 104 115 114
 104 105 116 115 105 106 117 116 106 107 118 117 107 108 119 118
 108 109 120 119 109 110 121 120
 122 123  123 124  124 125  125 126  126 127
 127 128  128 129
COMP GROU 2 'flui' LECT 1 PAS 1 100 TERM
            'stru' LECT 101 PAS 1 107 TERM
     NGRO 2 'blox' LECT 1 PAS 11 111 11 PAS 11 121 TERM
            'bloy' LECT 1 PAS 1 11 111 PAS 1 121 TERM
     COUL turq LECT flui TERM
          vert LECT stru TERM
     EPAI 0.01 LECT stru TERM
GRIL LAGR LECT stru TERM
     EULE LECT flui TERM
MATE FLUT RO 1.0 EINT 2.5E5 GAMM 1.4 PB 0
          ITER 1 ALF0 1 BET0 1 KINT 0 AHGF 0 CL 0.5
          CQ 2.56 PMIN 0 NUM 1 PREF 1.E5
          LECT flui _fl24 TERM
     VM23 RO 7800. YOUNG 1.6E11 NU 0.333 ELAS 1.05E8
          TRAC 2 1.05E8 .656256E-3 1.6105E10 1.00066
          LECT stru TERM
LINK COUP
     BLOQ 1 LECT blox TERM
     BLOQ 2 LECT bloy TERM
     FLSR STRU LECT stru TERM
          FLUI LECT flui TERM
          R 0.7072 ! so that d = 2r = 1.4144
          HGRI 1.6
          DGRI
         !BFLU 0 FSCP 1
          BFLU 0 FSCP 0
          ADAP LMAX 4
INIT VITE 1 100.0 LECT stru TERM
ECRI DEPL VITE ACCE FINT FEXT TFRE 10.E-3
          POIN LECT stru TERM
          ELEM LECT stru TERM
     FICH ALIC FREQ 1 !TFRE 1.E-3
OPTI NOTE
 CSTA 0.5 LOG 1 !dpma
 LNKS STAT
 ADAP RCON
CALCUL TINI 0. TEND 100.D-3
*=================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
SCEN OBJE SELV FLSR
     GEOM NAVI FREE
     FACE HFRO
     FLSR DOMA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 1124 FPS 15 KFRE 10 COMP -1 REND
FREQ 1 !FREQ 0 TFRE 1.E-3
GOTR LOOP 1122 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*=================================================================
SUIT
Post-treatment
ECHO
RESU ALIC GARD PSCR
SORT GRAP
AXTE 1.0 'Time [s]'
COUR 1 'dx_pcs' DEPL COMP 1 NOEU LECT 126 TERM
COUR 2 'vx_pcs' VITE COMP 1 NOEU LECT 126 TERM
TRAC 1 AXES 1.0 'DISPL. [M]'
TRAC 2 AXES 1.0 'VELOC. [M/S]'
LIST 1 AXES 1.0 'DISPL. [M]'
LIST 2 AXES 1.0 'VELOC. [M/S]'
*=================================================================
FIN
```

fsia09p.epx

```
FSIA09P
ECHO
RESU ALIC 'fsia09.ali' GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
*=================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
SCEN GEOM NAVI FREE
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 0.8E5 PAS 0.05E5 1.45E5 TERM
          SUPP LECT flui TERM
     TEXT ISCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 1124 FPS 15 KFRE 10 COMP -1 REND
FREQ 1
GOTR LOOP 1122 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*=================================================================
FIN
```

fsia09v.epx

```
FSIA09V
ECHO
RESU ALIC 'fsia09.ali' GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
*=================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
SCEN GEOM NAVI FREE
     FACE HFRO
     VECT SCCO FIEL VITE SCAL USER PROG 10 PAS 10 140 TERM
     TEXT VSCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 1124 FPS 15 KFRE 10 COMP -1 REND
FREQ 1
GOTR LOOP 1122 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*=================================================================
FIN
```

fsia10.epx

```
FSIA10
ECHO
!CONV win
DPLA ALE
DIME
  ADAP NPOI 563 FL24 664 ENDA
  NALE 1 NBLE 1
TERM
GEOM LIBR POIN 129 FL24 100 ED01 7 TERM
 0 0  1 0  2 0  3 0  4 0  5 0  6 0  7 0  8 0  9 0  10 0
 0 1  1 1  2 1  3 1  4 1  5 1  6 1  7 1  8 1  9 1  10 1
 0 2  1 2  2 2  3 2  4 2  5 2  6 2  7 2  8 2  9 2  10 2
 0 3  1 3  2 3  3 3  4 3  5 3  6 3  7 3  8 3  9 3  10 3
 0 4  1 4  2 4  3 4  4 4  5 4  6 4  7 4  8 4  9 4  10 4
 0 5  1 5  2 5  3 5  4 5  5 5  6 5  7 5  8 5  9 5  10 5
 0 6  1 6  2 6  3 6  4 6  5 6  6 6  7 6  8 6  9 6  10 6
 0 7  1 7  2 7  3 7  4 7  5 7  6 7  7 7  8 7  9 7  10 7
 0 8  1 8  2 8  3 8  4 8  5 8  6 8  7 8  8 8  9 8  10 8
 0 9  1 9  2 9  3 9  4 9  5 9  6 9  7 9  8 9  9 9  10 9
 0 10  1 10  2 10  3 10  4 10  5 10  6 10  7 10  8 10  9 10  10 10
 1.5 1.5  1.5 2.5  1.5 3.5  1.5 4.5
 1.5 5.5  1.5 6.5  1.5 7.5  1.5 8.5
 1 2 13 12   2 3 14 13   3 4 15 14   4 5 16 15   5 6 17 16
 6 7 18 17   7 8 19 18   8 9 20 19   9 10 21 20  10 11 22 21
 12 13 24 23 13 14 25 24 14 15 26 25 15 16 27 26 16 17 28 27
 17 18 29 28 18 19 30 29 19 20 31 30 20 21 32 31 21 22 33 32
 23 24 35 34 24 25 36 35 25 26 37 36 26 27 38 37 27 28 39 38
 28 29 40 39 29 30 41 40 30 31 42 41 31 32 43 42 32 33 44 43
 34 35 46 45 35 36 47 46 36 37 48 47 37 38 49 48 38 39 50 49
 39 40 51 50 40 41 52 51 41 42 53 52 42 43 54 53 43 44 55 54
 45 46 57 56 46 47 58 57 47 48 59 58 48 49 60 59 49 50 61 60
 50 51 62 61 51 52 63 62 52 53 64 63 53 54 65 64 54 55 66 65
 56 57 68 67 57 58 69 68 58 59 70 69 59 60 71 70 60 61 72 71
 61 62 73 72 62 63 74 73 63 64 75 74 64 65 76 75 65 66 77 76
 67 68 79 78 68 69 80 79 69 70 81 80 70 71 82 81 71 72 83 82
 72 73 84 83 73 74 85 84 74 75 86 85 75 76 87 86 76 77 88 87
 78 79 90 89 79 80 91 90 80 81 92 91 81 82 93 92 82 83 94 93
 83 84 95 94 84 85 96 95 85 86 97 96 86 87 98 97 87 88 99 98
 89 90 101 100 90 91 102 101 91 92 103 102 92 93 104 103
 93 94 105 104 94 95 106 105 95 96 107 106 96 97 108 107
 97 98 109 108 98 99 110 109
 100 101 112 111 101 102 113 112 102 103 114 113 103 104 115 114
 104 105 116 115 105 106 117 116 106 107 118 117 107 108 119 118
 108 109 120 119 109 110 121 120
 122 123  123 124  124 125  125 126  126 127
 127 128  128 129
COMP GROU 2 'flui' LECT 1 PAS 1 100 TERM
            'stru' LECT 101 PAS 1 107 TERM
     NGRO 2 'blox' LECT 1 PAS 11 111 11 PAS 11 121 TERM
            'bloy' LECT 1 PAS 1 11 111 PAS 1 121 TERM
     COUL turq LECT flui TERM
          vert LECT stru TERM
     EPAI 0.01 LECT stru TERM
GRIL LAGR LECT stru TERM
     EULE LECT flui TERM
MATE FLUT RO 1.0 EINT 2.5E5 GAMM 1.4 PB 0
          ITER 1 ALF0 1 BET0 1 KINT 0 AHGF 0 CL 0.5
          CQ 2.56 PMIN 0 NUM 1 PREF 1.E5
          LECT flui _fl24 TERM
     VM23 RO 7800. YOUNG 1.6E11 NU 0.333 ELAS 1.05E8
          TRAC 2 1.05E8 .656256E-3 1.6105E10 1.00066
          LECT stru TERM
LINK COUP
     BLOQ 1 LECT blox TERM
     BLOQ 2 LECT bloy TERM
     FLSR STRU LECT stru TERM
          FLUI LECT flui TERM
          R 0.7072 ! so that d = 2r = 1.4144
          HGRI 1.6
          DGRI
         !BFLU 0 FSCP 1
          BFLU 0 FSCP 0
          ADAP LMAX 4 SCAL 2.0
INIT VITE 1 100.0 LECT stru TERM
ECRI DEPL VITE ACCE FINT FEXT TFRE 10.E-3
```

```
          POIN LECT stru TERM
          ELEM LECT stru TERM
     FICH ALIC FREQ 1 !TFRE 1.E-3
OPTI NOTE
 CSTA 0.5 LOG 1 !dpma
 LNKS STAT
!ADAP RCON
CALCUL TINI 0. TEND 100.D-3
*==================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
SCEN OBJE SELV FLSR
     GEOM NAVI FREE
     FACE HFRO
     FLSR DOMA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 1133 FPS 15 KFRE 10 COMP -1 REND
FREQ 1 !FREQ 0 TFRE 1.E-3
GOTR LOOP 1131 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*==================================================================
SUIT
Post-treatment
ECHO
RESU ALIC GARD PSCR
SORT GRAP
AXTE 1.0 'Time [s]'
COUR 1 'dx_pcs' DEPL COMP 1 NOEU LECT 126 TERM
COUR 2 'vx_pcs' VITE COMP 1 NOEU LECT 126 TERM
TRAC 1 AXES 1.0 'DISPL. [M]'
TRAC 2 AXES 1.0 'VELOC. [M/S]'
LIST 1 AXES 1.0 'DISPL. [M]'
LIST 2 AXES 1.0 'VELOC. [M/S]'
*==================================================================
FIN
```

fsia10p.epx

```
FSIA10P
ECHO
RESU ALIC 'fsia10.ali' GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
*==================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
SCEN GEOM NAVI FREE
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 0.8E5 PAS 0.05E5 1.45E5 TERM
          SUPP LECT flui TERM
     TEXT ISCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 1133 FPS 15 KFRE 10 COMP -1 REND
FREQ 1
GOTR LOOP 1131 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*==================================================================
FIN
```

fsia10v.epx

```
FSIA10V
ECHO
RESU ALIC 'fsia10.ali' GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
*==================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
SCEN GEOM NAVI FREE
     FACE HFRO
     VECT SCCO FIEL VITE SCAL USER PROG 10 PAS 10 140 TERM
     TEXT VSCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 1133 FPS 15 KFRE 10 COMP -1 REND
FREQ 1
GOTR LOOP 1131 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*==================================================================
FIN
```

fsia11.dgibi

```
opti echo 1;
opti dime 2 elem qua4;
opti titr 'FSIA11';
opti sauv form 'fsia11.msh';
opti trac psc ftra 'fsia11_mesh.ps';
p1 = 0 0;
p2 = 10 0;
p3 = 10 10;
p4 = 0 10;
n = 10;
c1 = p1 d n p2;
c2 = p2 d n p3;
c3 = p3 d n p4;
c4 = p4 d n p1;
flui = dall c1 c2 c3 c4 plan;
p1s = 1.5 1.5;
pcs = 1.5 5.5;
p2s = 1.5 8.5;
ns1 = 4;
ns2 = 3;
stru = p1s d ns1 pcs d ns2 p2s;
mesh = flui et stru;
tass mesh;
sauv form mesh;
trac qual mesh;
fin;
```

fsia11.epx

```
FSIA11
ECHO
!CONV win
CAST mesh
DPLA ALE
DIME NALE 1 NBLE 1 TERM
GEOM FL24 flui ED01 stru TERM
COMP NGRO 2 'blox' LECT c2 c4 TERM
            'bloy' LECT c1 c3 TERM
     COUL turq LECT flui TERM
          vert LECT stru TERM
     EPAI 0.01 LECT stru TERM
GRIL LAGR LECT stru TERM
     EULE LECT flui TERM
MATE FLUT RO 1.0 EINT 2.5E5 GAMM 1.4 PB 0
          ITER 1 ALF0 1 BET0 1 KINT 0 AHGF 0 CL 0.5
          CQ 2.56 PMIN 0 NUM 1 PREF 1.E5
          LECT flui TERM
     VM23 RO 7800. YOUNG 1.6E11 NU 0.333 ELAS 1.05E8
          TRAC 2 1.05E8 .656256E-3 1.6105E10 1.00066
          LECT stru TERM
LINK COUP
     BLOQ 1 LECT blox TERM
     BLOQ 2 LECT bloy TERM
     FLSR STRU LECT stru TERM
          FLUI LECT flui TERM
          R 0.7072 ! so that d = 2r = 1.4144
          HGRI 1.6
          DGRI
         !BFLU 0 FSCP 1
          BFLU 0 FSCP 0
INIT VITE 1 100.0 LECT stru TERM
ECRI DEPL VITE ACCE FINT FEXT TFRE 10.E-3
          POIN LECT stru TERM
          ELEM LECT stru TERM
     FICH ALIC FREQ 1 !TFRE 1.E-3
OPTI NOTE
 CSTA 0.5 LOG 1 !dpma
 LNKS STAT
CALCUL TINI 0. TEND 100.D-3
*==================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
SCEN OBJE SELV FLSR
     GEOM NAVI FREE
     FACE HFRO
     FLSR DOMA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 962 FPS 15 KFRE 10 COMP -1 REND
FREQ 1 !FREQ 0 TFRE 1.E-3
GOTR LOOP 960 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*==================================================================
SUIT
Post-treatment
ECHO
RESU ALIC GARD PSCR
SORT GRAP
AXTE 1.0 'Time [s]'
COUR 1 'dx_pcs' DEPL COMP 1 NOEU LECT pcs TERM
COUR 2 'vx_pcs' VITE COMP 1 NOEU LECT pcs TERM
TRAC 1 AXES 1.0 'DISPL. [M]'
TRAC 2 AXES 1.0 'VELOC. [M/S]'
LIST 1 AXES 1.0 'DISPL. [M]'
LIST 2 AXES 1.0 'VELOC. [M/S]'
*==================================================================
FIN
```

fsia11p.epx

```
FSIA11P
ECHO
RESU ALIC 'fsia11.ali' GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
*==================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
```

```
        UP    0.00000E+00  1.00000E+00  0.00000E+00
        FOV   2.48819E+01
SCEN GEOM NAVI FREE
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 0.8E5 PAS 0.05E5 1.45E5 TERM
          SUPP LECT flui TERM
     TEXT ISCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 962 FPS 15 KFRE 10 COMP -1 REND
FREQ 1
GOTR LOOP 960 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*==================================================================
FIN
```

fsia11v.epx

```
FSIA11V
ECHO
RESU ALIC 'fsia11.ali' GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
*==================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
SCEN GEOM NAVI FREE
     FACE HFRO
     VECT SCCO FIEL VITE SCAL USER PROG 10 PAS 10 140 TERM
     TEXT VSCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 962 FPS 15 KFRE 10 COMP -1 REND
FREQ 1
GOTR LOOP 960 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*==================================================================
FIN
```

fsia12.dgibi

```
opti echo 1;
opti dime 2 elem qua4;
opti titr 'FSIA12';
opti sauv form 'fsia12.msh';
opti trac psc ftra 'fsia12_mesh.ps';
p1 = 0 0;
p2 = 10 0;
p3 = 10 10;
p4 = 0 10;
n = 20;
c1 = p1 d n p2;
c2 = p2 d n p3;
c3 = p3 d n p4;
c4 = p4 d n p1;
flui = dall c1 c2 c3 c4 plan;
p1s = 1.5 1.5;
pcs = 1.5 5.5;
p2s = 1.5 8.5;
ns1 = 4;
ns2 = 3;
stru = p1s d ns1 pcs d ns2 p2s;
mesh = flui et stru;
tass mesh;
sauv form mesh;
trac qual mesh;
fin;
```

fsia12.epx

```
FSIA12
ECHO
!CONV win
CAST mesh
DPLA ALE
DIME NALE 1 NBLE 1 TERM
GEOM FL24 flui ED01 stru TERM
COMP NGRO 2 'blox' LECT c2 c4 TERM
            'bloy' LECT c1 c3 TERM
     COUL turq LECT flui TERM
          vert LECT stru TERM
     EPAI 0.01 LECT stru TERM
GRIL LAGR LECT stru TERM
     EULE LECT flui TERM
MATE FLUT RO 1.0 EINT 2.5E5 GAMM 1.4 PB 0
          ITER 1 ALF0 1 BET0 1 KINT 0 AHGF 0 CL 0.5
          CQ 2.56 PMIN 0 NUM 1 PREF 1.E5
          LECT flui TERM
     VM23 RO 7800. YOUNG 1.6E11 NU 0.333 ELAS 1.05E8
          TRAC 2 1.05E8 .656256E-3 1.6105E10 1.00066
          LECT stru TERM
LINK COUP
     BLOQ 1 LECT blox TERM
     BLOQ 2 LECT bloy TERM
     FLSR STRU LECT stru TERM
          FLUI LECT flui TERM
          R 0.3536 ! so that d = 2r = 0.7072
          HGRI 1.6
          DGRI
         !BFLU 0 FSCP 1
          BFLU 0 FSCP 0
INIT VITE 1 100.0 LECT stru TERM
ECRI DEPL VITE ACCE FINT FEXT TFRE 10.E-3
          POIN LECT stru TERM
          ELEM LECT stru TERM
     FICH ALIC FREQ 1 !TFRE 1.E-3
OPTI NOTE
 CSTA 0.5 LOG 1 !dpma
 LNKS STAT
CALCUL TINI 0. TEND 100.D-3
*==================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
SCEN OBJE SELV FLSR
     GEOM NAVI FREE
     FACE HFRO
     FLSR DOMA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 962 FPS 15 KFRE 10 COMP -1 REND
FREQ 1 !FREQ 0 TFRE 1.E-3
GOTR LOOP 960 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*==================================================================
SUIT
Post-treatment
ECHO
RESU ALIC GARD PSCR
SORT GRAP
AXTE 1.0 'Time [s]'
COUR 1 'dx_pcs' DEPL COMP 1 NOEU LECT pcs TERM
COUR 2 'vx_pcs' VITE COMP 1 NOEU LECT pcs TERM
TRAC 1 AXES 1.0 'DISPL. [M]'
TRAC 2 AXES 1.0 'VELOC. [M/S]'
LIST 1 AXES 1.0 'DISPL. [M]'
LIST 2 AXES 1.0 'VELOC. [M/S]'
*==================================================================
FIN
```

fsia12p.epx

```
FSIA12P
ECHO
RESU ALIC 'fsia12.ali' GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
*==================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
SCEN GEOM NAVI FREE
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 0.8E5 PAS 0.05E5 1.45E5 TERM
          SUPP LECT flui TERM
     TEXT ISCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 962 FPS 15 KFRE 10 COMP -1 REND
FREQ 1
GOTR LOOP 960 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*==================================================================
FIN
```

fsia12v.epx

```
FSIA12V
ECHO
RESU ALIC 'fsia12.ali' GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
*==================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
SCEN GEOM NAVI FREE
     FACE HFRO
     VECT SCCO FIEL VITE SCAL USER PROG 10 PAS 10 140 TERM
     TEXT VSCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 962 FPS 15 KFRE 10 COMP -1 REND
FREQ 1
GOTR LOOP 960 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*==================================================================
FIN
```

fsia13.dgibi

```
opti echo 1;
opti dime 2 elem qua4;
opti titr 'FSIA13';
opti sauv form 'fsia13.msh';
opti trac psc ftra 'fsia13_mesh.ps';
p1 = 0 0;
```

```
p2 = 10 0;
p3 = 10 10;
p4 = 0 10;
n = 40;
c1 = p1 d n p2;
c2 = p2 d n p3;
c3 = p3 d n p4;
c4 = p4 d n p1;
flui = dall c1 c2 c3 c4 plan;
p1s = 1.5 1.5;
pcs = 1.5 5.5;
p2s = 1.5 8.5;
ns1 = 4;
ns2 = 3;
stru = p1s d ns1 pcs d ns2 p2s;
mesh = flui et stru;
tass mesh;
sauv form mesh;
trac qual mesh;
fin;
```

fsia13.epx

```
FSIA13
ECHO
!CONV win
CAST mesh
DPLA ALE
DIME NALE 1 NBLE 1 TERM
GEOM FL24 flui ED01 stru TERM
COMP NGRO 2 'blox' LECT c2 c4 TERM
             'bloy' LECT c1 c3 TERM
     COUL turq LECT flui TERM
          vert LECT stru TERM
     EPAI 0.01 LECT stru TERM
GRIL LAGR LECT stru TERM
     EULE LECT flui TERM
MATE FLUT RO 1.0 EINT 2.5E5 GAMM 1.4 PB 0
          ITER 1 ALF0 1 BET0 1 KINT 0 AHGF 0 CL 0.5
          CQ 2.56 PMIN 0 NUM 1 PREF 1.E5
          LECT flui TERM
     VM23 RO 7800. YOUNG 1.6E11 NU 0.333 ELAS 1.05E8
          TRAC 2 1.05E8 .656256E-3 1.6105E10 1.00066
          LECT stru TERM
LINK COUP
     BLOQ 1 LECT blox TERM
     BLOQ 2 LECT bloy TERM
     FLSR STRU LECT stru TERM
          FLUI LECT flui TERM
          R 0.1768 ! so that d = 2r = 0.3536
          HGRI 1.6
          DGRI
         !BFLU 0 FSCP 1
          BFLU 0 FSCP 0
INIT VITE 1 100.0 LECT stru TERM
ECRI DEPL VITE ACCE FINT FEXT TFRE 10.E-3
          POIN LECT stru TERM
          ELEM LECT stru TERM
     FICH ALIC FREQ 1 !TFRE 1.E-3
OPTI NOTE
 CSTA 0.5 LOG 1 !dpma
 LNKS STAT
CALCUL TINI 0. TEND 100.D-3
*=================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
!        Q      1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
SCEN OBJE SELV FLSR
     GEOM NAVI FREE
     FACE HFRO
     FLSR DOMA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 962 FPS 15 KFRE 10 COMP -1 REND
FREQ 1 !FREQ 0 TFRE 1.E-3
GOTR LOOP 960 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*=================================================================
SUIT
Post-treatment
ECHO
RESU ALIC GARD PSCR
SORT GRAP
AXTE 1.0 'Time [s]'
COUR 1 'dx_pcs' DEPL COMP 1 NOEU LECT pcs TERM
COUR 2 'vx_pcs' VITE COMP 1 NOEU LECT pcs TERM
TRAC 1 AXES 1.0 'DISPL. [M]'
TRAC 2 AXES 1.0 'VELOC. [M/S]'
LIST 1 AXES 1.0 'DISPL. [M]'
LIST 2 AXES 1.0 'VELOC. [M/S]'
*=================================================================
FIN
```

fsia13p.epx

```
FSIA13P
ECHO
RESU ALIC 'fsia13.ali' GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
*=================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
!        Q      1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
SCEN GEOM NAVI FREE
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 0.8E5 PAS 0.05E5 1.45E5 TERM
          SUPP LECT flui TERM
     TEXT ISCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 962 FPS 15 KFRE 10 COMP -1 REND
FREQ 1
GOTR LOOP 960 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*=================================================================
FIN
```

fsia13v.epx

```
FSIA13V
ECHO
RESU ALIC 'fsia13.ali' GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
*=================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
!        Q      1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
SCEN GEOM NAVI FREE
     FACE HFRO
     VECT SCCO FIEL VITE SCAL USER PROG 10 PAS 10 140 TERM
     TEXT VSCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 962 FPS 15 KFRE 10 COMP -1 REND
FREQ 1
GOTR LOOP 960 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*=================================================================
FIN
```

fsia14.dgibi

```
opti echo 1;
opti dime 2 elem qua4;
opti titr 'FSIA14';
opti sauv form 'fsia14.msh';
opti trac psc ftra 'fsia14_mesh.ps';
p1 = 0 0;
p2 = 10 0;
p3 = 10 10;
p4 = 0 10;
n = 80;
c1 = p1 d n p2;
c2 = p2 d n p3;
c3 = p3 d n p4;
c4 = p4 d n p1;
flui = dall c1 c2 c3 c4 plan;
p1s = 1.5 1.5;
pcs = 1.5 5.5;
p2s = 1.5 8.5;
ns1 = 4;
ns2 = 3;
stru = p1s d ns1 pcs d ns2 p2s;
mesh = flui et stru;
tass mesh;
sauv form mesh;
trac qual mesh;
fin;
```

fsia14.epx

```
FSIA14
ECHO
!CONV win
CAST mesh
DPLA ALE
DIME NALE 1 NBLE 1 TERM
GEOM FL24 flui ED01 stru TERM
COMP NGRO 2 'blox' LECT c2 c4 TERM
             'bloy' LECT c1 c3 TERM
     COUL turq LECT flui TERM
          vert LECT stru TERM
     EPAI 0.01 LECT stru TERM
GRIL LAGR LECT stru TERM
     EULE LECT flui TERM
MATE FLUT RO 1.0 EINT 2.5E5 GAMM 1.4 PB 0
          ITER 1 ALF0 1 BET0 1 KINT 0 AHGF 0 CL 0.5
          CQ 2.56 PMIN 0 NUM 1 PREF 1.E5
          LECT flui TERM
     VM23 RO 7800. YOUNG 1.6E11 NU 0.333 ELAS 1.05E8
          TRAC 2 1.05E8 .656256E-3 1.6105E10 1.00066
          LECT stru TERM
LINK COUP
     BLOQ 1 LECT blox TERM
     BLOQ 2 LECT bloy TERM
     FLSR STRU LECT stru TERM
          FLUI LECT flui TERM
          R 0.0884 ! so that d = 2r = 0.1768
          HGRI 1.6
          DGRI
         !BFLU 0 FSCP 1
          BFLU 0 FSCP 0
INIT VITE 1 100.0 LECT stru TERM
ECRI DEPL VITE ACCE FINT FEXT TFRE 10.E-3
          POIN LECT stru TERM
```

```
        ELEM LECT stru TERM
     FICH ALIC FREQ 1 !TFRE 1.E-3
OPTI NOTE
 CSTA 0.5 LOG 1 !dpma
 LNKS STAT
CALCUL TINI 0. TEND 100.D-3
*==================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
SCEN OBJE SELV FLSR
     GEOM NAVI FREE
     FACE HFRO
     FLSR DOMA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 1181 FPS 15 KFRE 10 COMP -1 REND
FREQ 1 !FREQ 0 TFRE 1.E-3
GOTR LOOP 1179 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*==================================================================
SUIT
Post-treatment
ECHO
RESU ALIC GARD PSCR
SORT GRAP
AXTE 1.0 'Time [s]'
COUR 1 'dx_pcs' DEPL COMP 1 NOEU LECT pcs TERM
COUR 2 'vx_pcs' VITE COMP 1 NOEU LECT pcs TERM
TRAC 1 AXES 1.0 'DISPL. [M]'
TRAC 2 AXES 1.0 'VELOC. [M/S]'
LIST 1 AXES 1.0 'DISPL. [M]'
LIST 2 AXES 1.0 'VELOC. [M/S]'
*==================================================================
FIN
```

fsia14compare.epx

```
FSIA14COMPARE
ECHO
RESU ALIC 'fsia14.ali' GARD PSCR
SORT GRAP
AXTE 1.0 'Time [s]'
RCOU 11 'dx_pcs' FICH 'fsia11.pun' RENA 'dx_pcs_11'
RCOU 12 'vx_pcs' FICH 'fsia11.pun' RENA 'vx_pcs_11'
RCOU 21 'dx_pcs' FICH 'fsia12.pun' RENA 'dx_pcs_12'
RCOU 22 'vx_pcs' FICH 'fsia12.pun' RENA 'vx_pcs_12'
RCOU 31 'dx_pcs' FICH 'fsia13.pun' RENA 'dx_pcs_13'
RCOU 32 'vx_pcs' FICH 'fsia13.pun' RENA 'vx_pcs_13'
RCOU 41 'dx_pcs' FICH 'fsia14.pun' RENA 'dx_pcs_14'
RCOU 42 'vx_pcs' FICH 'fsia14.pun' RENA 'vx_pcs_14'
RCOU 161 'dx_pcs' FICH 'fsia06.pun' RENA 'dx_pcs_06'
RCOU 162 'vx_pcs' FICH 'fsia06.pun' RENA 'vx_pcs_06'
RCOU 191 'dx_pcs' FICH 'fsia09.pun' RENA 'dx_pcs_09'
RCOU 192 'vx_pcs' FICH 'fsia09.pun' RENA 'vx_pcs_09'
RCOU 201 'dx_pcs' FICH 'fsia10.pun' RENA 'dx_pcs_10'
RCOU 202 'vx_pcs' FICH 'fsia10.pun' RENA 'vx_pcs_10'
TRAC 11 21 31 41 AXES 1.0 'DISPL. [M]'
COLO NOIR BLEU TURQ VERT
TRAC 12 22 32 42 AXES 1.0 'VELOC. [M/S]'
COLO NOIR BLEU TURQ VERT
TRAC 11 21 31 41 161 191 AXES 1.0 'DISPL. [M]'
COLO NOIR BLEU TURQ VERT ROSE ROUG
TRAC 12 22 32 42 162 192 AXES 1.0 'VELOC. [M/S]'
COLO NOIR BLEU TURQ VERT ROSE ROUG
TRAC 41 191 AXES 1.0 'DISPL. [M]'
COLO VERT ROUG
TRAC 42 192 AXES 1.0 'VELOC. [M/S]'
COLO VERT ROUG
TRAC 41 201 AXES 1.0 'DISPL. [M]'
COLO VERT ROUG
TRAC 42 202 AXES 1.0 'VELOC. [M/S]'
COLO VERT ROUG
*==================================================================
FIN
```

fsia14p.epx

```
FSIA14P
ECHO
RESU ALIC 'fsia14.ali' GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
*==================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
SCEN GEOM NAVI FREE
     LINE HEOU SFRE
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 0.8E5 PAS 0.05E5 1.45E5 TERM
          SUPP LECT flui TERM
     TEXT ISCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 1181 FPS 15 KFRE 10 COMP -1 REND
FREQ 1
GOTR LOOP 1179 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*==================================================================
FIN
```

fsia14v.epx

```
FSIA14V
ECHO
RESU ALIC 'fsia14.ali' GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
*==================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
SCEN GEOM NAVI FREE
     FACE HFRO
     VECT SCCO FIEL VITE SCAL USER PROG 10 PAS 10 140 TERM
     TEXT VSCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 1181 FPS 15 KFRE 10 COMP -1 REND
FREQ 1
GOTR LOOP 1179 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*==================================================================
FIN
```

fsia16.epx

```
FSIA16
ECHO
!CONV win
DPLA ALE
DIME
  ADAP NPOI 205 Q4VF 232 NVFI 526 ENDA
  NALE 1 NBLE 1
TERM
GEOM LIBR POIN 129 Q4VF 100 ED01 7 TERM
 0 0  1 0  2 0  3 0  4 0  5 0  6 0  7 0  8 0  9 0  10 0
 0 1  1 1  2 1  3 1  4 1  5 1  6 1  7 1  8 1  9 1  10 1
 0 2  1 2  2 2  3 2  4 2  5 2  6 2  7 2  8 2  9 2  10 2
 0 3  1 3  2 3  3 3  4 3  5 3  6 3  7 3  8 3  9 3  10 3
 0 4  1 4  2 4  3 4  4 4  5 4  6 4  7 4  8 4  9 4  10 4
 0 5  1 5  2 5  3 5  4 5  5 5  6 5  7 5  8 5  9 5  10 5
 0 6  1 6  2 6  3 6  4 6  5 6  6 6  7 6  8 6  9 6  10 6
 0 7  1 7  2 7  3 7  4 7  5 7  6 7  7 7  8 7  9 7  10 7
 0 8  1 8  2 8  3 8  4 8  5 8  6 8  7 8  8 8  9 8  10 8
 0 9  1 9  2 9  3 9  4 9  5 9  6 9  7 9  8 9  9 9  10 9
 0 10  1 10  2 10  3 10  4 10  5 10  6 10  7 10  8 10  9 10  10 10
 1.5 1.5  1.5 2.5  1.5 3.5  1.5 4.5
 1.5 5.5  1.5 6.5  1.5 7.5  1.5 8.5
 1 2 13 12   2 3 14 13   3 4 15 14   4 5 16 15   5 6 17 16
 6 7 18 17   7 8 19 18   8 9 20 19   9 10 21 20  10 11 22 21
 12 13 24 23 13 14 25 24 14 15 26 25 15 16 27 26 16 17 28 27
 17 18 29 28 18 19 30 29 19 20 31 30 20 21 32 31 21 22 33 32
 23 24 35 34 24 25 36 35 25 26 37 36 26 27 38 37 27 28 39 38
 28 29 40 39 29 30 41 40 30 31 42 41 31 32 43 42 32 33 44 43
 34 35 46 45 35 36 47 46 36 37 48 47 37 38 49 48 38 39 50 49
 39 40 51 50 40 41 52 51 41 42 53 52 42 43 54 53 43 44 55 54
 45 46 57 56 46 47 58 57 47 48 59 58 48 49 60 59 49 50 61 60
 50 51 62 61 51 52 63 62 52 53 64 63 53 54 65 64 54 55 66 65
 56 57 68 67 57 58 69 68 58 59 70 69 59 60 71 70 60 61 72 71
 61 62 73 72 62 63 74 73 63 64 75 74 64 65 76 75 65 66 77 76
 67 68 79 78 68 69 80 79 69 70 81 80 70 71 82 81 71 72 83 82
 72 73 84 83 73 74 85 84 74 75 86 85 75 76 87 86 76 77 88 87
 78 79 90 89 79 80 91 90 80 81 92 91 81 82 93 92 82 83 94 93
 83 84 95 94 84 85 96 95 85 86 97 96 86 87 98 97 87 88 99 98
 89 90 101 100 90 91 102 101 91 92 103 102 92 93 104 103
 93 94 105 104 94 95 106 105 95 96 107 106 96 97 108 107
 97 98 109 108 98 99 110 109
 100 101 112 111 101 102 113 112 102 103 114 113 103 104 115 114
 104 105 116 115 105 106 117 116 106 107 118 117 107 108 119 118
 108 109 120 119 109 110 121 120
 122 123  123 124  124 125  125 126  126 127
 127 128  128 129
COMP GROU 2 'flui' LECT 1 PAS 1 100 TERM
            'stru' LECT 101 PAS 1 107 TERM
     NGRO 2 'blox' LECT 1 PAS 11 111 11 PAS 11 121 TERM
            'bloy' LECT 1 PAS 1 11 111 PAS 1 121 TERM
     COUL turq LECT flui TERM
          vert LECT stru TERM
     EPAI 0.01 LECT stru TERM
GRIL LAGR LECT stru TERM
     EULE LECT flui TERM
MATE GAZP RO 1.0 GAMM 1.4 PINI 1.E5 PREF 1.E5
          LECT flui _q4vf TERM
     VM23 RO 7800. YOUNG 1.6E11 NU 0.333 ELAS 1.05E8
          TRAC 2 1.05E8 .656256E-3 1.6105E10 1.00066
          LECT stru TERM
LINK DECO
     FLSW STRU LECT stru TERM
          FLUI LECT flui TERM
          R 0.7072 ! so that d = 2r = 1.4144
          HGRI 1.6
          DGRI
          FACE
          BFLU 1 FSCP 0
          ADAP LMAX 3
INIT VITE 1 100.0 LECT stru TERM
ECRI DEPL VITE ACCE FINT FEXT VFCC TFRE 10.E-3
          POIN LECT stru TERM
          ELEM LECT stru TERM
     FICH ALIC FREQ 1 !TFRE 1.E-3
OPTI NOTE
 CSTA 0.5 LOG 1 !dpma
 LNKS STAT
 ADAP RCON
CALCUL TINI 0. TEND 100.D-3
*==================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
```

```
!        Q      1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
SCEN OBJE !SELV FLSW
     GEOM NAVI FREE
     FACE HFRO
     FLSW DOMA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 962 FPS 15 KFRE 10 COMP -1 REND
FREQ 1 !FREQ 0 TFRE 1.E-3
GOTR LOOP 960 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*==================================================================
SUIT
Post-treatment
ECHO
RESU ALIC GARD PSCR
SORT GRAP
AXTE 1.0 'Time [s]'
COUR 1 'dx_pcs' DEPL COMP 1 NOEU LECT 126 TERM
COUR 2 'vx_pcs' VITE COMP 1 NOEU LECT 126 TERM
TRAC 1 AXES 1.0 'DISPL. [M]'
TRAC 2 AXES 1.0 'VELOC. [M/S]'
LIST 1 AXES 1.0 'DISPL. [M]'
LIST 2 AXES 1.0 'VELOC. [M/S]'
*==================================================================
FIN
```

fsia16p.epx

```
FSIA16P
ECHO
RESU ALIC 'fsia16.ali' GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
*==================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
!        Q      1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
SCEN GEOM NAVI FREE
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 0.8E5 PAS 0.05E5 1.45E5 TERM
          SUPP LECT flui TERM
     TEXT ISCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 962 FPS 15 KFRE 10 COMP -1 REND
FREQ 1
GOTR LOOP 960 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*==================================================================
FIN
```

fsia16v.epx

```
FSIA16V
ECHO
RESU ALIC 'fsia16.ali' GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
*==================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
!        Q      1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
SCEN GEOM NAVI FREE
     FACE HFRO
     VECT SCCO FIEL VCVI SCAL USER PROG 10 PAS 10 140 TERM
          SUPP LECT flui TERM
     TEXT VSCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 962 FPS 15 KFRE 10 COMP -1 REND
FREQ 1
GOTR LOOP 960 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*==================================================================
FIN
```

fsia19.epx

```
FSIA19
ECHO
!CONV win
DPLA ALE
DIME
  ADAP NPOI 472 Q4VF 544 NVFI 1216 ENDA
  NALE 1 NBLE 1
TERM
GEOM LIBR POIN 129 Q4VF 100 ED01 7 TERM
 0 0  1 0  2 0  3 0  4 0  5 0  6 0  7 0  8 0  9 0  10 0
 0 1  1 1  2 1  3 1  4 1  5 1  6 1  7 1  8 1  9 1  10 1
 0 2  1 2  2 2  3 2  4 2  5 2  6 2  7 2  8 2  9 2  10 2
 0 3  1 3  2 3  3 3  4 3  5 3  6 3  7 3  8 3  9 3  10 3
 0 4  1 4  2 4  3 4  4 4  5 4  6 4  7 4  8 4  9 4  10 4
 0 5  1 5  2 5  3 5  4 5  5 5  6 5  7 5  8 5  9 5  10 5
 0 6  1 6  2 6  3 6  4 6  5 6  6 6  7 6  8 6  9 6  10 6
 0 7  1 7  2 7  3 7  4 7  5 7  6 7  7 7  8 7  9 7  10 7
 0 8  1 8  2 8  3 8  4 8  5 8  6 8  7 8  8 8  9 8  10 8
 0 9  1 9  2 9  3 9  4 9  5 9  6 9  7 9  8 9  9 9  10 9
 0 10  1 10  2 10  3 10  4 10  5 10  6 10  7 10  8 10  9 10  10 10
 1.5 1.5  1.5 2.5  1.5 3.5  1.5 4.5
 1.5 5.5  1.5 6.5  1.5 7.5  1.5 8.5
 1 2 13 12   2 3 14 13   3 4 15 14   4 5 16 15   5 6 17 16
 6 7 18 17   7 8 19 18   8 9 20 19   9 10 21 20  10 11 22 21
 12 13 24 23 13 14 25 24 14 15 26 25 15 16 27 26 16 17 28 27
 17 18 29 28 18 19 30 29 19 20 31 30 20 21 32 31 21 22 33 32
 23 24 35 34 24 25 36 35 25 26 37 36 26 27 38 37 27 28 39 38
 28 29 40 39 29 30 41 40 30 31 42 41 31 32 43 42 32 33 44 43
 34 35 46 45 35 36 47 46 36 37 48 47 37 38 49 48 38 39 50 49
 39 40 51 50 40 41 52 51 41 42 53 52 42 43 54 53 43 44 55 54
 45 46 57 56 46 47 58 57 47 48 59 58 48 49 60 59 49 50 61 60
 50 51 62 61 51 52 63 62 52 53 64 63 53 54 65 64 54 55 66 65
 56 57 68 67 57 58 69 68 58 59 70 69 59 60 71 70 60 61 72 71
 61 62 73 72 62 63 74 73 63 64 75 74 64 65 76 75 65 66 77 76
 67 68 79 78 68 69 80 79 69 70 81 80 70 71 82 81 71 72 83 82
 72 73 84 83 73 74 85 84 74 75 86 85 75 76 87 86 76 77 88 87
 78 79 90 89 79 80 91 90 80 81 92 91 81 82 93 92 82 83 94 93
 83 84 95 94 84 85 96 95 85 86 97 96 86 87 98 97 87 88 99 98
 89 90 101 100 90 91 102 101 91 92 103 102 92 93 104 103
 93 94 105 104 94 95 106 105 95 96 107 106 96 97 108 107
 97 98 109 108 98 99 110 109
 100 101 112 111 101 102 113 112 102 103 114 113 103 104 115 114
 104 105 116 115 105 106 117 116 106 107 118 117 107 108 119 118
 108 109 120 119 109 110 121 120
 122 123  123 124  124 125  125 126  126 127
 127 128  128 129
COMP GROU 2 'flui' LECT 1 PAS 1 100 TERM
            'stru' LECT 101 PAS 1 107 TERM
     NGRO 2 'blox' LECT 1 PAS 11 111 11 PAS 11 121 TERM
            'bloy' LECT 1 PAS 1 11 111 PAS 1 121 TERM
     COUL turq LECT flui TERM
          vert LECT stru TERM
     EPAI 0.01 LECT stru TERM
GRIL LAGR LECT stru TERM
     EULE LECT flui TERM
MATE GAZP RO 1.0 GAMM 1.4 PINI 1.E5 PREF 1.E5
          LECT flui _q4vf TERM
     VM23 RO 7800. YOUNG 1.6E11 NU 0.333 ELAS 1.05E8
          TRAC 2 1.05E8 .656256E-3 1.6105E10 1.00066
          LECT stru TERM
LINK DECO
     FLSW STRU LECT stru TERM
          FLUI LECT flui TERM
          R 0.7072 ! so that d = 2r = 1.4144
          HGRI 1.6
          DGRI
          FACE
          BFLU 1 FSCP 0
          ADAP LMAX 4
INIT VITE 1 100.0 LECT stru TERM
ECRI DEPL VITE ACCE FINT FEXT VFCC TFRE 10.E-3
          POIN LECT stru TERM
          ELEM LECT stru TERM
     FICH ALIC FREQ 1 !TFRE 1.E-3
OPTI NOTE
 CSTA 0.5 LOG 1 !dpma
 LNKS STAT
 ADAP RCON
CALCUL TINI 0. TEND 100.D-3
*==================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
!        Q      1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
SCEN OBJE !SELV FLSW
     GEOM NAVI FREE
     FACE HFRO
     FLSW DOMA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 962 FPS 15 KFRE 10 COMP -1 REND
FREQ 1 !FREQ 0 TFRE 1.E-3
GOTR LOOP 960 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*==================================================================
SUIT
Post-treatment
ECHO
RESU ALIC GARD PSCR
SORT GRAP
AXTE 1.0 'Time [s]'
COUR 1 'dx_pcs' DEPL COMP 1 NOEU LECT 126 TERM
COUR 2 'vx_pcs' VITE COMP 1 NOEU LECT 126 TERM
TRAC 1 AXES 1.0 'DISPL. [M]'
TRAC 2 AXES 1.0 'VELOC. [M/S]'
LIST 1 AXES 1.0 'DISPL. [M]'
LIST 2 AXES 1.0 'VELOC. [M/S]'
*==================================================================
FIN
```

fsia19p.epx

```
FSIA19P
ECHO
RESU ALIC 'fsia19.ali' GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
*==================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
!        Q      1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
SCEN GEOM NAVI FREE
```

```
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 0.8E5 PAS 0.05E5 1.45E5 TERM
          SUPP LECT flui TERM
     TEXT ISCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 962 FPS 15 KFRE 10 COMP -1 REND
FREQ 1
GOTR LOOP 960 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*=================================================================
FIN
```

fsia19v.epx

```
FSIA19V
ECHO
RESU ALIC 'fsia19.ali' GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
*=================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
SCEN GEOM NAVI FREE
     FACE HFRO
     VECT SCCO FIEL VCVI SCAL USER PROG 10 PAS 10 140 TERM
          SUPP LECT flui TERM
     TEXT VSCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 962 FPS 15 KFRE 10 COMP -1 REND
FREQ 1
GOTR LOOP 960 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*=================================================================
FIN
```

fsia20.epx

```
FSIA20
ECHO
!CONV win
DPLA ALE
DIME
  ADAP NPOI 1000 Q4VF 1000 NVFI 2000 ENDA
  NALE 1 NBLE 1
TERM
GEOM LIBR POIN 129 Q4VF 100 ED01 7 TERM
 0 0  1 0  2 0  3 0  4 0  5 0  6 0  7 0  8 0  9 0  10 0
 0 1  1 1  2 1  3 1  4 1  5 1  6 1  7 1  8 1  9 1  10 1
 0 2  1 2  2 2  3 2  4 2  5 2  6 2  7 2  8 2  9 2  10 2
 0 3  1 3  2 3  3 3  4 3  5 3  6 3  7 3  8 3  9 3  10 3
 0 4  1 4  2 4  3 4  4 4  5 4  6 4  7 4  8 4  9 4  10 4
 0 5  1 5  2 5  3 5  4 5  5 5  6 5  7 5  8 5  9 5  10 5
 0 6  1 6  2 6  3 6  4 6  5 6  6 6  7 6  8 6  9 6  10 6
 0 7  1 7  2 7  3 7  4 7  5 7  6 7  7 7  8 7  9 7  10 7
 0 8  1 8  2 8  3 8  4 8  5 8  6 8  7 8  8 8  9 8  10 8
 0 9  1 9  2 9  3 9  4 9  5 9  6 9  7 9  8 9  9 9  10 9
 0 10  1 10  2 10  3 10  4 10  5 10  6 10  7 10  8 10  9 10  10 10
 1.5 1.5  1.5 2.5  1.5 3.5  1.5 4.5
 1.5 5.5  1.5 6.5  1.5 7.5  1.5 8.5
 1 2 13 12   2 3 14 13   3 4 15 14   4 5 16 15   5 6 17 16
 6 7 18 17   7 8 19 18   8 9 20 19   9 10 21 20  10 11 22 21
 12 13 24 23 13 14 25 24 14 15 26 25 15 16 27 26 16 17 28 27
 17 18 29 28 18 19 30 29 19 20 31 30 20 21 32 31 21 22 33 32
 23 24 35 34 24 25 36 35 25 26 37 36 26 27 38 37 27 28 39 38
 28 29 40 39 29 30 41 40 30 31 42 41 31 32 43 42 32 33 44 43
 34 35 46 45 35 36 47 46 36 37 48 47 37 38 49 48 38 39 50 49
 39 40 51 50 40 41 52 51 41 42 53 52 42 43 54 53 43 44 55 54
 45 46 57 56 46 47 58 57 47 48 59 58 48 49 60 59 49 50 61 60
 50 51 62 61 51 52 63 62 52 53 64 63 53 54 65 64 54 55 66 65
 56 57 68 67 57 58 69 68 58 59 70 69 59 60 71 70 60 61 72 71
 61 62 73 72 62 63 74 73 63 64 75 74 64 65 76 75 65 66 77 76
 67 68 79 78 68 69 80 79 69 70 81 80 70 71 82 81 71 72 83 82
 72 73 84 83 73 74 85 84 74 75 86 85 75 76 87 86 76 77 88 87
 78 79 90 89 79 80 91 90 80 81 92 91 81 82 93 92 82 83 94 93
 83 84 95 94 84 85 96 95 85 86 97 96 86 87 98 97 87 88 99 98
 89 90 101 100 90 91 102 101 91 92 103 102 92 93 104 103
 93 94 105 104 94 95 106 105 95 96 107 106 96 97 108 107
 97 98 109 108 98 99 110 109
 100 101 112 111 101 102 113 112 102 103 114 113 103 104 115 114
 104 105 116 115 105 106 117 116 106 107 118 117 107 108 119 118
 108 109 120 119 109 110 121 120
 122 123  123 124  124 125  125 126  126 127
 127 128  128 129
COMP GROU 2 'flui' LECT 1 PAS 1 100 TERM
            'stru' LECT 101 PAS 1 107 TERM
     NGRO 2 'blox' LECT 1 PAS 11 111 11 PAS 11 121 TERM
            'bloy' LECT 1 PAS 1 11 111 PAS 1 121 TERM
     COUL turq LECT flui TERM
          vert LECT stru TERM
     EPAI 0.01 LECT stru TERM
GRIL LAGR LECT stru TERM
     EULE LECT flui TERM
MATE GAZP RO 1.0 GAMM 1.4 PINI 1.E5 PREF 1.E5
          LECT flui _q4vf TERM
     VM23 RO 7800. YOUNG 1.6E11 NU 0.333 ELAS 1.05E8
          TRAC 2 1.05E8 .656256E-3 1.6105E10 1.00066
          LECT stru TERM
LINK DECO
     FLSW STRU LECT stru TERM
          FLUI LECT flui TERM
          R 0.7072 ! so that d = 2r = 1.4144
          HGRI 1.6
          DGRI
          FACE
          BFLU 1 FSCP 0
          ADAP LMAX 4 SCAL 2.0
INIT VITE 1 100.0 LECT stru TERM
ECRI DEPL VITE ACCE FINT FEXT VFCC TFRE 10.E-3
          POIN LECT stru TERM
          ELEM LECT stru TERM
     FICH ALIC FREQ 1 !TFRE 1.E-3
OPTI NOTE
 CSTA 0.5 LOG 1 !dpma
 LNKS STAT
!ADAP RCON
CALCUL TINI 0. TEND 100.D-3
*=================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
SCEN OBJE !SELV FLSW
     GEOM NAVI FREE
     FACE HFRO
     FLSW DOMA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 962 FPS 15 KFRE 10 COMP -1 REND
FREQ 1 !FREQ 0 TFRE 1.E-3
GOTR LOOP 960 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*=================================================================
SUIT
Post-treatment
ECHO
RESU ALIC GARD PSCR
SORT GRAP
AXTE 1.0 'Time [s]'
COUR 1 'dx_pcs' DEPL COMP 1 NOEU LECT 126 TERM
COUR 2 'vx_pcs' VITE COMP 1 NOEU LECT 126 TERM
TRAC 1 AXES 1.0 'DISPL. [M]'
TRAC 2 AXES 1.0 'VELOC. [M/S]'
LIST 1 AXES 1.0 'DISPL. [M]'
LIST 2 AXES 1.0 'VELOC. [M/S]'
*=================================================================
FIN
```

fsia20p.epx

```
FSIA20P
ECHO
RESU ALIC 'fsia20.ali' GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
*=================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
SCEN GEOM NAVI FREE
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 0.8E5 PAS 0.05E5 1.45E5 TERM
          SUPP LECT flui TERM
     TEXT ISCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 962 FPS 15 KFRE 10 COMP -1 REND
FREQ 1
GOTR LOOP 960 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*=================================================================
FIN
```

fsia20v.epx

```
FSIA20V
ECHO
RESU ALIC 'fsia20.ali' GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
*=================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
SCEN GEOM NAVI FREE
     FACE HFRO
     VECT SCCO FIEL VCVI SCAL USER PROG 10 PAS 10 140 TERM
          SUPP LECT flui TERM
     TEXT VSCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 962 FPS 15 KFRE 10 COMP -1 REND
FREQ 1
GOTR LOOP 960 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*=================================================================
FIN
```

fsia21.dgibi

```
opti echo 1;
opti dime 2 elem qua4;
opti titr 'FSIA21';
opti sauv form 'fsia21.msh';
opti trac psc ftra 'fsia21_mesh.ps';
p1 = 0 0;
p2 = 10 0;
p3 = 10 10;
p4 = 0 10;
n = 10;
c1 = p1 d n p2;
c2 = p2 d n p3;
c3 = p3 d n p4;
c4 = p4 d n p1;
flui = dall c1 c2 c3 c4 plan;
p1s = 1.5 1.5;
pcs = 1.5 5.5;
p2s = 1.5 8.5;
ns1 = 4;
ns2 = 3;
stru = p1s d ns1 pcs d ns2 p2s;
mesh = flui et stru;
tass mesh;
sauv form mesh;
trac qual mesh;
fin;
```

fsia21.epx

```
FSIA21
ECHO
!CONV win
CAST mesh
DPLA ALE
DIME NALE 1 NBLE 1 TERM
GEOM Q4VF flui ED01 stru TERM
COMP NGRO 2 'blox' LECT c2 c4 TERM
            'bloy' LECT c1 c3 TERM
     COUL turq LECT flui TERM
          vert LECT stru TERM
     EPAI 0.01 LECT stru TERM
GRIL LAGR LECT stru TERM
     EULE LECT flui TERM
MATE GAZP RO 1.0 GAMM 1.4 PINI 1.E5 PREF 1.E5
          LECT flui TERM
     VM23 RO 7800. YOUNG 1.6E11 NU 0.333 ELAS 1.05E8
          TRAC 2 1.05E8 .656256E-3 1.6105E10 1.00066
          LECT stru TERM
LINK DECO
     FLSW STRU LECT stru TERM
          FLUI LECT flui TERM
          R 0.7072 ! so that d = 2r = 1.4144
          HGRI 1.6
          DGRI
          FACE
          BFLU 1 FSCP 0
INIT VITE 1 100.0 LECT stru TERM
ECRI DEPL VITE ACCE FINT FEXT VFCC TFRE 10.E-3
          POIN LECT stru TERM
          ELEM LECT stru TERM
     FICH ALIC FREQ 1 !TFRE 1.E-3
OPTI NOTE
 CSTA 0.5 LOG 1 !dpma
 LNKS STAT
CALCUL TINI 0. TEND 100.D-3
*=================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
SCEN OBJE !SELV FLSW
     GEOM NAVI FREE
     FACE HFRO
     FLSW DOMA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 962 FPS 15 KFRE 10 COMP -1 REND
FREQ 1 !FREQ 0 TFRE 1.E-3
GOTR LOOP 960 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*=================================================================
SUIT
Post-treatment
ECHO
RESU ALIC GARD PSCR
SORT GRAP
AXTE 1.0 'Time [s]'
COUR 1 'dx_pcs' DEPL COMP 1 NOEU LECT pcs TERM
COUR 2 'vx_pcs' VITE COMP 1 NOEU LECT pcs TERM
TRAC 1 AXES 1.0 'DISPL. [M]'
TRAC 2 AXES 1.0 'VELOC. [M/S]'
LIST 1 AXES 1.0 'DISPL. [M]'
LIST 2 AXES 1.0 'VELOC. [M/S]'
*=================================================================
FIN
```

fsia21p.epx

```
FSIA21P
ECHO
RESU ALIC 'fsia21.ali' GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
*=================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
SCEN GEOM NAVI FREE
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 0.8E5 PAS 0.05E5 1.45E5 TERM
          SUPP LECT flui TERM
     TEXT ISCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 962 FPS 15 KFRE 10 COMP -1 REND
FREQ 1
GOTR LOOP 960 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*=================================================================
FIN
```

fsia21v.epx

```
FSIA21V
ECHO
RESU ALIC 'fsia21.ali' GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
*=================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
SCEN GEOM NAVI FREE
     FACE HFRO
     VECT SCCO FIEL VCVI SCAL USER PROG 10 PAS 10 140 TERM
          SUPP LECT flui TERM
     TEXT VSCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 962 FPS 15 KFRE 10 COMP -1 REND
FREQ 1
GOTR LOOP 960 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*=================================================================
FIN
```

fsia22.dgibi

```
opti echo 1;
opti dime 2 elem qua4;
opti titr 'FSIA22';
opti sauv form 'fsia22.msh';
opti trac psc ftra 'fsia22_mesh.ps';
p1 = 0 0;
p2 = 10 0;
p3 = 10 10;
p4 = 0 10;
n = 20;
c1 = p1 d n p2;
c2 = p2 d n p3;
c3 = p3 d n p4;
c4 = p4 d n p1;
flui = dall c1 c2 c3 c4 plan;
p1s = 1.5 1.5;
pcs = 1.5 5.5;
p2s = 1.5 8.5;
ns1 = 4;
ns2 = 3;
stru = p1s d ns1 pcs d ns2 p2s;
mesh = flui et stru;
tass mesh;
sauv form mesh;
trac qual mesh;
fin;
```

fsia22.epx

```
FSIA22
ECHO
!CONV win
CAST mesh
DPLA ALE
DIME NALE 1 NBLE 1 TERM
GEOM Q4VF flui ED01 stru TERM
COMP NGRO 2 'blox' LECT c2 c4 TERM
            'bloy' LECT c1 c3 TERM
     COUL turq LECT flui TERM
          vert LECT stru TERM
     EPAI 0.01 LECT stru TERM
GRIL LAGR LECT stru TERM
     EULE LECT flui TERM
MATE GAZP RO 1.0 GAMM 1.4 PINI 1.E5 PREF 1.E5
          LECT flui TERM
     VM23 RO 7800. YOUNG 1.6E11 NU 0.333 ELAS 1.05E8
          TRAC 2 1.05E8 .656256E-3 1.6105E10 1.00066
          LECT stru TERM
LINK DECO
     FLSW STRU LECT stru TERM
          FLUI LECT flui TERM
          R 0.3536 ! so that d = 2r = 0.7072
          HGRI 1.6
          DGRI
          FACE
          BFLU 1 FSCP 0
INIT VITE 1 100.0 LECT stru TERM
```

```
ECRI DEPL VITE ACCE FINT FEXT VFCC TFRE 10.E-3
          POIN LECT stru TERM
          ELEM LECT stru TERM
     FICH ALIC FREQ 1 !TFRE 1.E-3
OPTI NOTE
 CSTA 0.5 LOG 1 !dpma
 LNKS STAT
CALCUL TINI 0. TEND 100.D-3
*=================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
SCEN OBJE !SELV FLSW
     GEOM NAVI FREE
     FACE HFRO
     FLSW DOMA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 962 FPS 15 KFRE 10 COMP -1 REND
FREQ 1 !FREQ 0 TFRE 1.E-3
GOTR LOOP 960 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*=================================================================
SUIT
Post-treatment
ECHO
RESU ALIC GARD PSCR
SORT GRAP
AXTE 1.0 'Time [s]'
COUR 1 'dx_pcs' DEPL COMP 1 NOEU LECT pcs TERM
COUR 2 'vx_pcs' VITE COMP 1 NOEU LECT pcs TERM
TRAC 1 AXES 1.0 'DISPL. [M]'
TRAC 2 AXES 1.0 'VELOC. [M/S]'
LIST 1 AXES 1.0 'DISPL. [M]'
LIST 2 AXES 1.0 'VELOC. [M/S]'
*=================================================================
FIN
```

fsia22p.epx

```
FSIA22P
ECHO
RESU ALIC 'fsia22.ali' GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
*=================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
SCEN GEOM NAVI FREE
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 0.8E5 PAS 0.05E5 1.45E5 TERM
          SUPP LECT flui TERM
     TEXT ISCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 962 FPS 15 KFRE 10 COMP -1 REND
FREQ 1
GOTR LOOP 960 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*=================================================================
FIN
```

fsia22v.epx

```
FSIA22V
ECHO
RESU ALIC 'fsia22.ali' GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
*=================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
SCEN GEOM NAVI FREE
     FACE HFRO
     VECT SCCO FIEL VCVI SCAL USER PROG 10 PAS 10 140 TERM
          SUPP LECT flui TERM
     TEXT VSCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 962 FPS 15 KFRE 10 COMP -1 REND
FREQ 1
GOTR LOOP 960 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*=================================================================
FIN
```

fsia23.dgibi

```
opti echo 1;
opti dime 2 elem qua4;
opti titr 'FSIA23';
opti sauv form 'fsia23.msh';
opti trac psc ftra 'fsia23_mesh.ps';
p1 = 0 0;
p2 = 10 0;
p3 = 10 10;
p4 = 0 10;
n = 40;
c1 = p1 d n p2;
c2 = p2 d n p3;
c3 = p3 d n p4;
c4 = p4 d n p1;
flui = dall c1 c2 c3 c4 plan;
p1s = 1.5 1.5;
pcs = 1.5 5.5;
p2s = 1.5 8.5;
ns1 = 4;
ns2 = 3;
stru = p1s d ns1 pcs d ns2 p2s;
mesh = flui et stru;
tass mesh;
sauv form mesh;
trac qual mesh;
fin;
```

fsia23.epx

```
FSIA23
ECHO
!CONV win
CAST mesh
DPLA ALE
DIME NALE 1 NBLE 1 TERM
GEOM Q4VF flui ED01 stru TERM
COMP NGRO 2 'blox' LECT c2 c4 TERM
            'bloy' LECT c1 c3 TERM
     COUL turq LECT flui TERM
          vert LECT stru TERM
     EPAI 0.01 LECT stru TERM
GRIL LAGR LECT stru TERM
     EULE LECT flui TERM
MATE GAZP RO 1.0 GAMM 1.4 PINI 1.E5 PREF 1.E5
          LECT flui TERM
     VM23 RO 7800. YOUNG 1.6E11 NU 0.333 ELAS 1.05E8
          TRAC 2 1.05E8 .656256E-3 1.6105E10 1.00066
          LECT stru TERM
LINK DECO
     FLSW STRU LECT stru TERM
          FLUI LECT flui TERM
          R 0.1768 ! so that d = 2r = 0.3536
          HGRI 1.6
          DGRI
          FACE
          BFLU 1 FSCP 0
INIT VITE 1 100.0 LECT stru TERM
ECRI DEPL VITE ACCE FINT FEXT VFCC TFRE 10.E-3
          POIN LECT stru TERM
          ELEM LECT stru TERM
     FICH ALIC FREQ 1 !TFRE 1.E-3
OPTI NOTE
 CSTA 0.5 LOG 1 !dpma
 LNKS STAT
CALCUL TINI 0. TEND 100.D-3
*=================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
SCEN OBJE !SELV FLSW
     GEOM NAVI FREE
     FACE HFRO
     FLSW DOMA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 962 FPS 15 KFRE 10 COMP -1 REND
FREQ 1 !FREQ 0 TFRE 1.E-3
GOTR LOOP 960 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*=================================================================
SUIT
Post-treatment
ECHO
RESU ALIC GARD PSCR
SORT GRAP
AXTE 1.0 'Time [s]'
COUR 1 'dx_pcs' DEPL COMP 1 NOEU LECT pcs TERM
COUR 2 'vx_pcs' VITE COMP 1 NOEU LECT pcs TERM
TRAC 1 AXES 1.0 'DISPL. [M]'
TRAC 2 AXES 1.0 'VELOC. [M/S]'
LIST 1 AXES 1.0 'DISPL. [M]'
LIST 2 AXES 1.0 'VELOC. [M/S]'
*=================================================================
FIN
```

fsia23p.epx

```
FSIA23P
ECHO
RESU ALIC 'fsia23.ali' GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
*=================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
SCEN GEOM NAVI FREE
```

```
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 0.8E5 PAS 0.05E5 1.45E5 TERM
          SUPP LECT flui TERM
     TEXT ISCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 962 FPS 15 KFRE 10 COMP -1 REND
FREQ 1
GOTR LOOP 960 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*=================================================================
FIN
```

fsia23v.epx

```
FSIA23V
ECHO
RESU ALIC 'fsia23.ali' GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
*=================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
SCEN GEOM NAVI FREE
     FACE HFRO
     VECT SCCO FIEL VCVI SCAL USER PROG 10 PAS 10 140 TERM
          SUPP LECT flui TERM
     TEXT VSCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 962 FPS 15 KFRE 10 COMP -1 REND
FREQ 1
GOTR LOOP 960 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*=================================================================
FIN
```

fsia24.dgibi

```
opti echo 1;
opti dime 2 elem qua4;
opti titr 'FSIA24';
opti sauv form 'fsia24.msh';
opti trac psc ftra 'fsia24_mesh.ps';
p1 = 0 0;
p2 = 10 0;
p3 = 10 10;
p4 = 0 10;
n = 80;
c1 = p1 d n p2;
c2 = p2 d n p3;
c3 = p3 d n p4;
c4 = p4 d n p1;
flui = dall c1 c2 c3 c4 plan;
p1s = 1.5 1.5;
pcs = 1.5 5.5;
p2s = 1.5 8.5;
ns1 = 4;
ns2 = 3;
stru = p1s d ns1 pcs d ns2 p2s;
mesh = flui et stru;
tass mesh;
sauv form mesh;
trac qual mesh;
fin;
```

fsia24.epx

```
FSIA24
ECHO
!CONV win
CAST mesh
DPLA ALE
DIME NALE 1 NBLE 1 TERM
GEOM Q4VF flui ED01 stru TERM
COMP NGRO 2 'blox' LECT c2 c4 TERM
            'bloy' LECT c1 c3 TERM
     COUL turq LECT flui TERM
          vert LECT stru TERM
     EPAI 0.01 LECT stru TERM
GRIL LAGR LECT stru TERM
     EULE LECT flui TERM
MATE GAZP RO 1.0 GAMM 1.4 PINI 1.E5 PREF 1.E5
          LECT flui TERM
     VM23 RO 7800. YOUNG 1.6E11 NU 0.333 ELAS 1.05E8
          TRAC 2 1.05E8 .656256E-3 1.6105E10 1.00066
          LECT stru TERM
LINK DECO
     FLSW STRU LECT stru TERM
          FLUI LECT flui TERM
          R 0.0884 ! so that d = 2r = 0.1768
          HGRI 1.6
          DGRI
          FACE
          BFLU 1 FSCP 0
INIT VITE 1 100.0 LECT stru TERM
ECRI DEPL VITE ACCE FINT FEXT VFCC TFRE 10.E-3
          POIN LECT stru TERM
          ELEM LECT stru TERM
     FICH ALIC FREQ 1 !TFRE 1.E-3
OPTI NOTE
 CSTA 0.5 LOG 1 !dpma
 LNKS STAT
CALCUL TINI 0. TEND 100.D-3
*=================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
SCEN OBJE !SELV FLSW
     GEOM NAVI FREE
     FACE HFRO
     FLSW DOMA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 1027 FPS 15 KFRE 10 COMP -1 REND
FREQ 1 !FREQ 0 TFRE 1.E-3
GOTR LOOP 1025 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*=================================================================
SUIT
Post-treatment
ECHO
RESU ALIC GARD PSCR
SORT GRAP
AXTE 1.0 'Time [s]'
COUR 1 'dx_pcs' DEPL COMP 1 NOEU LECT pcs TERM
COUR 2 'vx_pcs' VITE COMP 1 NOEU LECT pcs TERM
TRAC 1 AXES 1.0 'DISPL. [M]'
TRAC 2 AXES 1.0 'VELOC. [M/S]'
LIST 1 AXES 1.0 'DISPL. [M]'
LIST 2 AXES 1.0 'VELOC. [M/S]'
*=================================================================
FIN
```

fsia24compare.epx

```
FSIA24COMPARE
ECHO
RESU ALIC 'fsia24.ali' GARD PSCR
SORT GRAP
AXTE 1.0 'Time [s]'
RCOU 11 'dx_pcs' FICH 'fsia21.pun' RENA 'dx_pcs_21'
RCOU 12 'vx_pcs' FICH 'fsia21.pun' RENA 'vx_pcs_21'
RCOU 21 'dx_pcs' FICH 'fsia22.pun' RENA 'dx_pcs_22'
RCOU 22 'vx_pcs' FICH 'fsia22.pun' RENA 'vx_pcs_22'
RCOU 31 'dx_pcs' FICH 'fsia23.pun' RENA 'dx_pcs_23'
RCOU 32 'vx_pcs' FICH 'fsia23.pun' RENA 'vx_pcs_23'
RCOU 41 'dx_pcs' FICH 'fsia24.pun' RENA 'dx_pcs_24'
RCOU 42 'vx_pcs' FICH 'fsia24.pun' RENA 'vx_pcs_24'
RCOU 161 'dx_pcs' FICH 'fsia16.pun' RENA 'dx_pcs_16'
RCOU 162 'vx_pcs' FICH 'fsia16.pun' RENA 'vx_pcs_16'
RCOU 191 'dx_pcs' FICH 'fsia19.pun' RENA 'dx_pcs_19'
RCOU 192 'vx_pcs' FICH 'fsia19.pun' RENA 'vx_pcs_19'
RCOU 201 'dx_pcs' FICH 'fsia20.pun' RENA 'dx_pcs_20'
RCOU 202 'vx_pcs' FICH 'fsia20.pun' RENA 'vx_pcs_20'
RCOU 141 'dx_pcs' FICH 'fsia14.pun' RENA 'dx_pcs_14' ! FE
RCOU 142 'vx_pcs' FICH 'fsia14.pun' RENA 'vx_pcs_14' ! FE
TRAC 11 21 31 41 AXES 1.0 'DISPL. [M]'
COLO NOIR BLEU TURQ VERT
TRAC 12 22 32 42 AXES 1.0 'VELOC. [M/S]'
COLO NOIR BLEU TURQ VERT
TRAC 11 21 31 41 161 191 AXES 1.0 'DISPL. [M]'
COLO NOIR BLEU TURQ VERT ROSE ROUG
TRAC 12 22 32 42 162 192 AXES 1.0 'VELOC. [M/S]'
COLO NOIR BLEU TURQ VERT ROSE ROUG
TRAC 41 191 AXES 1.0 'DISPL. [M]'
COLO VERT ROUG
TRAC 42 192 AXES 1.0 'VELOC. [M/S]'
COLO VERT ROUG
TRAC 41 141 AXES 1.0 'DISPL. [M]'
COLO VERT ROUG
TRAC 42 142 AXES 1.0 'VELOC. [M/S]'
COLO VERT ROUG
TRAC 41 201 AXES 1.0 'DISPL. [M]'
COLO VERT ROUG
TRAC 42 202 AXES 1.0 'VELOC. [M/S]'
COLO VERT ROUG
*=================================================================
FIN
```

fsia24p.epx

```
FSIA24P
ECHO
RESU ALIC 'fsia24.ali' GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
*=================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
SCEN GEOM NAVI FREE
     LINE HEOU SFRE
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 0.8E5 PAS 0.05E5 1.45E5 TERM
          SUPP LECT flui TERM
     TEXT ISCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 1027 FPS 15 KFRE 10 COMP -1 REND
FREQ 1
GOTR LOOP 1025 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*=================================================================
FIN
```

fsia24v.epx

```
FSIA24V
ECHO
RESU ALIC 'fsia24.ali' GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
*=================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
SCEN GEOM NAVI FREE
     FACE HFRO
     VECT SCCO FIEL VCVI SCAL USER PROG 10 PAS 10 140 TERM
          SUPP LECT flui TERM
     TEXT VSCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 1027 FPS 15 KFRE 10 COMP -1 REND
FREQ 1
GOTR LOOP 1025 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*=================================================================
FIN
```

fsia26.dgibi

```
opti echo 1;
opti dime 3 elem cub8;
opti titr 'FSIA26';
opti sauv form 'fsia26.msh';
opti trac psc ftra 'fsia26_mesh.ps';
p1 = 0 0 0;
p2 = 10 0 0;
p3 = 10 10 0;
p4 = 0 10 0;
pz = 0 0 10;
n = 10;
c1 = p1 d n p2;
c2 = p2 d n p3;
c3 = p3 d n p4;
c4 = p4 d n p1;
base = dall c1 c2 c3 c4 plan;
flui = base volu tran n pz;
fsrn = enve flui;
p1s = 1.5 1.5 1.5;
pcs = 1.5 5.5 1.5;
p2s = 1.5 8.5 1.5;
pzs = 0 0 7;
ns1 = 4;
ns2 = 3;
bstru = p1s d ns1 pcs d ns2 p2s;
stru = bstru tran (ns1+ns2) pzs;
mesh = flui et stru et fsrn;
tass mesh;
sauv form mesh;
trac mesh;
trac cach qual mesh;
fin;
```

fsia26.epx

```
FSIA26
ECHO
!CONV win
CAST mesh
TRID ALE
DIME
  ADAP NPOI 10000 FL38 10000 ENDA
  NALE 1 NBLE 1
TERM
GEOM FL38 flui Q4GS stru TERM
COMP NGRO 1 'cs' LECT stru TERM COND NEAR POIN 1.5 5 5
     COUL turq LECT flui TERM
          vert LECT stru TERM
     EPAI 0.01 LECT stru TERM
GRIL LAGR LECT stru TERM
     EULE LECT flui TERM
MATE FLUT RO 1.0 EINT 2.5E5 GAMM 1.4 PB 0
          ITER 1 ALF0 1 BET0 1 KINT 0 AHGF 0 CL 0.5
          CQ 2.56 PMIN 0 NUM 1 PREF 1.E5
          LECT flui _fl38 TERM
     VM23 RO 7800. YOUNG 1.6E11 NU 0.333 ELAS 1.05E8
          TRAC 2 1.05E8 .656256E-3 1.6105E10 1.00066
          LECT stru TERM
LINK COUP
     FSR  LECT fsrn TERM
     FLSR STRU LECT stru TERM
          FLUI LECT flui TERM
          R 0.87 ! so that d = 2r = 1.74
          HGRI 1.6
          DGRI
          BFLU 0 FSCP 0
          ADAP LMAX 3
INIT VITE 1 100.0 LECT stru TERM
ECRI DEPL VITE ACCE FINT FEXT TFRE 10.E-3
          POIN LECT stru TERM
          ELEM LECT stru TERM
     FICH SPLI ALIC FREQ 1 !TFRE 1.E-3
OPTI NOTE
 CSTA 0.5 LOG 1 !dpma
 LNKS STAT
 ADAP RCON
CALCUL TINI 0. TEND 100.D-3
FIN
```

fsia26a.epx

```
FSIA26A
ECHO
RESU SPLI ALIC 'fsia26.ali' GARD PSCR
COMP NGRO 1 'cs' LECT stru TERM COND NEAR POIN 1.5 5 5
SORT GRAP
PERF 'fsia26.pun'
AXTE 1.0 'Time [s]'
COUR 1 'dx_cs' DEPL COMP 1 NOEU LECT cs TERM
COUR 2 'vx_cs' VITE COMP 1 NOEU LECT cs TERM
TRAC 1 AXES 1.0 'DISPL. [M]'
TRAC 2 AXES 1.0 'VELOC. [M/S]'
LIST 1 AXES 1.0 'DISPL. [M]'
LIST 2 AXES 1.0 'VELOC. [M/S]'
*=================================================================
FIN
```

fsia26b.epx

```
FSIA26B
ECHO
RESU SPLI ALIC 'fsia26.ali' GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
*=================================================================
PLAY
CAME   1 EYE   5.00000E+00 -3.68258E+01  1.62072E+01
!        Q     7.93353E-01  6.08761E-01  4.52854E-19  3.43977E-18
         VIEW -4.90654E-18  9.65926E-01 -2.58819E-01
         RIGH  1.00000E+00  6.00926E-18  3.46945E-18
         UP   -4.90654E-18  2.58819E-01  9.65926E-01
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  5.00000E+00  5.00000E+00  5.00000E+00
!RSPHERE:  8.66025E+00
!RADIUS :  4.33013E+01
!ASPECT :  1.00000E+00
!NEAR   :  3.37750E+01
!FAR    :  6.06218E+01
SCEN OBJE !SELV FLSR
          !USLM LECT flui TERM DHAS CGLA
     GEOM NAVI FREE
          REFE BBOX
     FACE HFRO
     LINE HEOU SFRE
     FLSR DOMA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 967 FPS 15 KFRE 10 COMP -1 REND
FREQ 1 !FREQ 0 TFRE 1.E-3
GOTR LOOP 965 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*=================================================================
FIN
```

fsia26p.epx

```
FSIA26P
ECHO
RESU SPLI ALIC 'fsia26.ali' GARD PSCR
!COMP GROU 1 'ygt5' LECT tous TERM COND YB GT 4.9
OPTI PRIN
SORT VISU NSTO 1
*=================================================================
PLAY
CAME   1 EYE   5.00000E+00 -3.68258E+01  1.62072E+01
!        Q     7.93353E-01  6.08761E-01  4.52854E-19  3.43977E-18
         VIEW -4.90654E-18  9.65926E-01 -2.58819E-01
         RIGH  1.00000E+00  6.00926E-18  3.46945E-18
         UP   -4.90654E-18  2.58819E-01  9.65926E-01
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  5.00000E+00  5.00000E+00  5.00000E+00
!RSPHERE:  8.66025E+00
!RADIUS :  4.33013E+01
!ASPECT :  1.00000E+00
!NEAR   :  3.37750E+01
!FAR    :  6.06218E+01
SCEN GEOM NAVI FREE
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 0.8E5 PAS 0.05E5 1.45E5 TERM
          SUPP LECT flui TERM
     TEXT ISCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 967 FPS 15 KFRE 10 COMP -1
!    OBJE LECT ygt5 TERM REND
     REND
FREQ 1
GOTR LOOP 965 OFFS FICH AVI CONT NOCL
!    OBJE LECT ygt5 TERM REND
     REND
GO
TRAC OFFS FICH AVI CONT
!    OBJE LECT ygt5 TERM REND
     REND
ENDPLAY
*=================================================================
FIN
```

fsia26v.epx

```
FSIA26V
ECHO
RESU SPLI ALIC 'fsia26.ali' GARD PSCR
!COMP GROU 1 'ygt5' LECT tous TERM COND YB GT 4.9
OPTI PRIN
```

```
SORT VISU NSTO 1
*================================================================
PLAY
CAME   1 EYE   5.00000E+00 -3.68258E+01  1.62072E+01
!        Q     7.93353E-01  6.08761E-01  4.52854E-19  3.43977E-18
         VIEW -4.90654E-18  9.65926E-01 -2.58819E-01
         RIGH  1.00000E+00  6.00926E-18  3.46945E-18
         UP   -4.90654E-18  2.58819E-01  9.65926E-01
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  5.00000E+00  5.00000E+00  5.00000E+00
!RSPHERE:  8.66025E+00
!RADIUS :  4.33013E+01
!ASPECT :  1.00000E+00
!NEAR   :  3.37750E+01
!FAR    :  6.06218E+01
SCEN GEOM NAVI FREE
     FACE HFRO
     VECT SCCO FIEL VITE SCAL USER PROG 10 PAS 10 140 TERM
          SIVE
     TEXT VSCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 967 FPS 15 KFRE 10 COMP -1
!    OBJE LECT ygt5 TERM REND
     REND
FREQ 1
GOTR LOOP 965 OFFS FICH AVI CONT NOCL
!    OBJE LECT ygt5 TERM REND
     REND
GO
TRAC OFFS FICH AVI CONT
!    OBJE LECT ygt5 TERM REND
     REND
ENDPLAY
*================================================================
FIN
```

fsia31.dgibi

```
opti echo 1;
opti dime 3 elem cub8;
opti titr 'FSIA31';
opti sauv form 'fsia31.msh';
opti trac psc ftra 'fsia31_mesh.ps';
p1 = 0 0 0;
p2 = 10 0 0;
p3 = 10 10 0;
p4 = 0 10 0;
pz = 0 0 10;
n = 10;
c1 = p1 d n p2;
c2 = p2 d n p3;
c3 = p3 d n p4;
c4 = p4 d n p1;
base = dall c1 c2 c3 c4 plan;
flui = base volu tran n pz;
fsrn = enve flui;
p1s = 1.5 1.5 1.5;
pcs = 1.5 5.5 1.5;
p2s = 1.5 8.5 1.5;
pzs = 0 0 7;
ns1 = 4;
ns2 = 3;
bstru = p1s d ns1 pcs d ns2 p2s;
stru = bstru tran (ns1+ns2) pzs;
mesh = flui et stru et fsrn;
tass mesh;
sauv form mesh;
trac mesh;
trac cach qual mesh;
fin;
```

fsia31.epx

```
FSIA31
ECHO
!CONV win
CAST mesh
TRID ALE
DIME NALE 1 NBLE 1 TERM
GEOM FL38 flui Q4GS stru TERM
COMP NGRO 1 'cs' LECT stru TERM COND NEAR POIN 1.5 5 5
     COUL turq LECT flui TERM
          vert LECT stru TERM
     EPAI 0.01 LECT stru TERM
GRIL LAGR LECT stru TERM
     EULE LECT flui TERM
MATE FLUT RO 1.0 EINT 2.5E5 GAMM 1.4 PB 0
          ITER 1 ALF0 1 BET0 1 KINT 0 AHGF 0 CL 0.5
          CQ 2.56 PMIN 0 NUM 1 PREF 1.E5
          LECT flui TERM
     VM23 RO 7800. YOUNG 1.6E11 NU 0.333 ELAS 1.05E8
          TRAC 2 1.05E8 .656256E-3 1.6105E10 1.00066
          LECT stru TERM
LINK COUP
     FSR  LECT fsrn TERM
     FLSR STRU LECT stru TERM
          FLUI LECT flui TERM
          R 0.87 ! so that d = 2r = 1.74
          HGRI 1.6
          DGRI
         !BFLU 0 FSCP 1
          BFLU 0 FSCP 0
INIT VITE 1 100.0 LECT stru TERM
ECRI DEPL VITE ACCE FINT FEXT TFRE 10.E-3
          POIN LECT stru TERM
          ELEM LECT stru TERM
     FICH ALIC FREQ 1 !TFRE 1.E-3
OPTI NOTE
 CSTA 0.5 LOG 1 !dpma
 LNKS STAT
CALCUL TINI 0. TEND 100.D-3
*================================================================
PLAY
CAME   1 EYE   5.00000E+00 -3.68258E+01  1.62072E+01
!        Q     7.93353E-01  6.08761E-01  4.52854E-19  3.43977E-18
         VIEW -4.90654E-18  9.65926E-01 -2.58819E-01
         RIGH  1.00000E+00  6.00926E-18  3.46945E-18
         UP   -4.90654E-18  2.58819E-01  9.65926E-01
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  5.00000E+00  5.00000E+00  5.00000E+00
!RSPHERE:  8.66025E+00
!RADIUS :  4.33013E+01
!ASPECT :  1.00000E+00
!NEAR   :  3.37750E+01
!FAR    :  6.06218E+01
SCEN OBJE SELV FLSR
     GEOM NAVI FREE
     FACE HFRO
     LINE HEOU SSHA SFRE
     FLSR DOMA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 967 FPS 15 KFRE 10 COMP -1 REND
FREQ 1 !FREQ 0 TFRE 1.E-3
GOTR LOOP 965 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*================================================================
SUIT
Post-treatment
ECHO
RESU ALIC GARD PSCR
SORT GRAP
AXTE 1.0 'Time [s]'
COUR 1 'dx_cs' DEPL COMP 1 NOEU LECT cs TERM
COUR 2 'vx_cs' VITE COMP 1 NOEU LECT cs TERM
TRAC 1 AXES 1.0 'DISPL. [M]'
TRAC 2 AXES 1.0 'VELOC. [M/S]'
LIST 1 AXES 1.0 'DISPL. [M]'
LIST 2 AXES 1.0 'VELOC. [M/S]'
*================================================================
FIN
```

fsia31p.epx

```
FSIA31P
ECHO
RESU ALIC 'fsia31.ali' GARD PSCR
COMP GROU 1 'ygt5' LECT tous TERM COND YB GT 4.9
OPTI PRIN
SORT VISU NSTO 1
*================================================================
PLAY
CAME   1 EYE   5.00000E+00 -3.68258E+01  1.62072E+01
!        Q     7.93353E-01  6.08761E-01  4.52854E-19  3.43977E-18
         VIEW -4.90654E-18  9.65926E-01 -2.58819E-01
         RIGH  1.00000E+00  6.00926E-18  3.46945E-18
         UP   -4.90654E-18  2.58819E-01  9.65926E-01
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  5.00000E+00  5.00000E+00  5.00000E+00
!RSPHERE:  8.66025E+00
!RADIUS :  4.33013E+01
!ASPECT :  1.00000E+00
!NEAR   :  3.37750E+01
!FAR    :  6.06218E+01
SCEN GEOM NAVI FREE
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 0.8E5 PAS 0.05E5 1.45E5 TERM
          SUPP LECT flui TERM
     TEXT ISCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 967 FPS 15 KFRE 10 COMP -1
     OBJE LECT ygt5 TERM REND
FREQ 1
GOTR LOOP 965 OFFS FICH AVI CONT NOCL
     OBJE LECT ygt5 TERM REND
GO
TRAC OFFS FICH AVI CONT
     OBJE LECT ygt5 TERM REND
ENDPLAY
*================================================================
FIN
```

fsia31v.epx

```
FSIA31V
ECHO
RESU ALIC 'fsia31.ali' GARD PSCR
COMP GROU 1 'ygt5' LECT tous TERM COND YB GT 4.9
OPTI PRIN
SORT VISU NSTO 1
*================================================================
PLAY
CAME   1 EYE   5.00000E+00 -3.68258E+01  1.62072E+01
!        Q     7.93353E-01  6.08761E-01  4.52854E-19  3.43977E-18
         VIEW -4.90654E-18  9.65926E-01 -2.58819E-01
         RIGH  1.00000E+00  6.00926E-18  3.46945E-18
         UP   -4.90654E-18  2.58819E-01  9.65926E-01
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  5.00000E+00  5.00000E+00  5.00000E+00
!RSPHERE:  8.66025E+00
!RADIUS :  4.33013E+01
!ASPECT :  1.00000E+00
!NEAR   :  3.37750E+01
!FAR    :  6.06218E+01
SCEN GEOM NAVI FREE
     FACE HFRO
     VECT SCCO FIEL VITE SCAL USER PROG 10 PAS 10 140 TERM
          SIVE
     TEXT VSCA
```

```
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 967 FPS 15 KFRE 10 COMP -1
     OBJE LECT ygt5 TERM REND
FREQ 1
GOTR LOOP 965 OFFS FICH AVI CONT NOCL
     OBJE LECT ygt5 TERM REND
GO
TRAC OFFS FICH AVI CONT
     OBJE LECT ygt5 TERM REND
ENDPLAY
*=================================================================
FIN
```

fsia32.dgibi

```
opti echo 1;
opti dime 3 elem cub8;
opti titr 'FSIA32';
opti sauv form 'fsia32.msh';
opti trac psc ftra 'fsia32_mesh.ps';
p1 = 0 0 0;
p2 = 10 0 0;
p3 = 10 10 0;
p4 = 0 10 0;
pz = 0 0 10;
n = 20;
c1 = p1 d n p2;
c2 = p2 d n p3;
c3 = p3 d n p4;
c4 = p4 d n p1;
base = dall c1 c2 c3 c4 plan;
flui = base volu tran n pz;
fsrn = enve flui;
p1s = 1.5 1.5 1.5;
pcs = 1.5 5.5 1.5;
p2s = 1.5 8.5 1.5;
pzs = 0 0 7;
ns1 = 4;
ns2 = 3;
bstru = p1s d ns1 pcs d ns2 p2s;
stru = bstru tran (ns1+ns2) pzs;
mesh = flui et stru et fsrn;
tass mesh;
sauv form mesh;
trac mesh;
trac cach qual mesh;
fin;
```

fsia32.epx

```
FSIA32
ECHO
!CONV win
CAST mesh
TRID ALE
DIME NALE 1 NBLE 1 TERM
GEOM FL38 flui Q4GS stru TERM
COMP NGRO 1 'cs' LECT stru TERM COND NEAR POIN 1.5 5 5
     COUL turq LECT flui TERM
          vert LECT stru TERM
     EPAI 0.01 LECT stru TERM
GRIL LAGR LECT stru TERM
     EULE LECT flui TERM
MATE FLUT RO 1.0 EINT 2.5E5 GAMM 1.4 PB 0
          ITER 1 ALF0 1 BET0 1 KINT 0 AHGF 0 CL 0.5
          CQ 2.56 PMIN 0 NUM 1 PREF 1.E5
          LECT flui TERM
     VM23 RO 7800. YOUNG 1.6E11 NU 0.333 ELAS 1.05E8
          TRAC 2 1.05E8 .656256E-3 1.6105E10 1.00066
          LECT stru TERM
LINK COUP
     FSR  LECT fsrn TERM
     FLSR STRU LECT stru TERM
          FLUI LECT flui TERM
          R 0.435 ! so that d = 2r = 0.870
          HGRI 1.6
          DGRI
         !BFLU 0 FSCP 1
          BFLU 0 FSCP 0
INIT VITE 1 100.0 LECT stru TERM
ECRI DEPL VITE ACCE FINT FEXT TFRE 10.E-3
          POIN LECT stru TERM
          ELEM LECT stru TERM
     FICH ALIC FREQ 1 !TFRE 1.E-3
OPTI NOTE
 CSTA 0.5 LOG 1 !dpma
 LNKS STAT
CALCUL TINI 0. TEND 100.D-3
*=================================================================
PLAY
CAME   1 EYE   5.00000E+00 -3.68258E+01  1.62072E+01
!        Q     7.93353E-01  6.08761E-01  4.52854E-19  3.43977E-18
         VIEW -4.90654E-18  9.65926E-01 -2.58819E-01
         RIGH  1.00000E+00  6.00926E-18  3.46945E-18
         UP   -4.90654E-18  2.58819E-01  9.65926E-01
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  5.00000E+00  5.00000E+00  5.00000E+00
!RSPHERE:  8.66025E+00
!RADIUS :  4.33013E+01
!ASPECT :  1.00000E+00
!NEAR   :  3.37750E+01
!FAR    :  6.06218E+01
SCEN OBJE SELV FLSR
     GEOM NAVI FREE
     FACE HFRO
     LINE HEOU SSHA SFRE
     FLSR DOMA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 963 FPS 15 KFRE 10 COMP -1 REND
FREQ 1 !FREQ 0 TFRE 1.E-3
GOTR LOOP 961 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*=================================================================
SUIT
Post-treatment
ECHO
RESU ALIC GARD PSCR
SORT GRAP
AXTE 1.0 'Time [s]'
COUR 1 'dx_cs' DEPL COMP 1 NOEU LECT cs TERM
COUR 2 'vx_cs' VITE COMP 1 NOEU LECT cs TERM
TRAC 1 AXES 1.0 'DISPL. [M]'
TRAC 2 AXES 1.0 'VELOC. [M/S]'
LIST 1 AXES 1.0 'DISPL. [M]'
LIST 2 AXES 1.0 'VELOC. [M/S]'
*=================================================================
FIN
```

fsia32p.epx

```
FSIA32P
ECHO
RESU ALIC 'fsia32.ali' GARD PSCR
COMP GROU 1 'ygt5' LECT tous TERM COND YB GT 4.9
OPTI PRIN
SORT VISU NSTO 1
*=================================================================
PLAY
CAME   1 EYE   5.00000E+00 -3.68258E+01  1.62072E+01
!        Q     7.93353E-01  6.08761E-01  4.52854E-19  3.43977E-18
         VIEW -4.90654E-18  9.65926E-01 -2.58819E-01
         RIGH  1.00000E+00  6.00926E-18  3.46945E-18
         UP   -4.90654E-18  2.58819E-01  9.65926E-01
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  5.00000E+00  5.00000E+00  5.00000E+00
!RSPHERE:  8.66025E+00
!RADIUS :  4.33013E+01
!ASPECT :  1.00000E+00
!NEAR   :  3.37750E+01
!FAR    :  6.06218E+01
SCEN GEOM NAVI FREE
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 0.8E5 PAS 0.05E5 1.45E5 TERM
          SUPP LECT flui TERM
     TEXT ISCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 963 FPS 15 KFRE 10 COMP -1
     OBJE LECT ygt5 TERM REND
FREQ 1
GOTR LOOP 961 OFFS FICH AVI CONT NOCL
     OBJE LECT ygt5 TERM REND
GO
TRAC OFFS FICH AVI CONT
     OBJE LECT ygt5 TERM REND
ENDPLAY
*=================================================================
FIN
```

fsia32v.epx

```
FSIA32V
ECHO
RESU ALIC 'fsia32.ali' GARD PSCR
COMP GROU 1 'ygt5' LECT tous TERM COND YB GT 4.9
OPTI PRIN
SORT VISU NSTO 1
*=================================================================
PLAY
CAME   1 EYE   5.00000E+00 -3.68258E+01  1.62072E+01
!        Q     7.93353E-01  6.08761E-01  4.52854E-19  3.43977E-18
         VIEW -4.90654E-18  9.65926E-01 -2.58819E-01
         RIGH  1.00000E+00  6.00926E-18  3.46945E-18
         UP   -4.90654E-18  2.58819E-01  9.65926E-01
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  5.00000E+00  5.00000E+00  5.00000E+00
!RSPHERE:  8.66025E+00
!RADIUS :  4.33013E+01
!ASPECT :  1.00000E+00
!NEAR   :  3.37750E+01
!FAR    :  6.06218E+01
SCEN GEOM NAVI FREE
     FACE HFRO
     VECT SCCO FIEL VITE SCAL USER PROG 10 PAS 10 140 TERM
          SIVE
     TEXT VSCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 963 FPS 15 KFRE 10 COMP -1
     OBJE LECT ygt5 TERM REND
FREQ 1
GOTR LOOP 961 OFFS FICH AVI CONT NOCL
     OBJE LECT ygt5 TERM REND
GO
TRAC OFFS FICH AVI CONT
     OBJE LECT ygt5 TERM REND
ENDPLAY
*=================================================================
FIN
```

fsia33.dgibi

```
opti echo 1;
opti dime 3 elem cub8;
opti titr 'FSIA33';
opti sauv form 'fsia33.msh';
opti trac psc ftra 'fsia33_mesh.ps';
p1 = 0 0 0;
```

```
p2 = 10 0 0;
p3 = 10 10 0;
p4 = 0 10 0;
pz = 0 0 10;
n = 40;
c1 = p1 d n p2;
c2 = p2 d n p3;
c3 = p3 d n p4;
c4 = p4 d n p1;
base = dall c1 c2 c3 c4 plan;
flui = base volu tran n pz;
fsrn = enve flui;
p1s = 1.5 1.5 1.5;
pcs = 1.5 5.5 1.5;
p2s = 1.5 8.5 1.5;
pzs = 0 0 7;
ns1 = 4;
ns2 = 3;
bstru = p1s d ns1 pcs d ns2 p2s;
stru = bstru tran (ns1+ns2) pzs;
mesh = flui et stru et fsrn;
tass mesh;
sauv form mesh;
trac mesh;
trac cach qual mesh;
fin;
```

fsia33.epx

```
FSIA33
ECHO
!CONV win
CAST mesh
TRID ALE
DIME NALE 1 NBLE 1 TERM
GEOM FL38 flui Q4GS stru TERM
COMP NGRO 1 'cs' LECT stru TERM COND NEAR POIN 1.5 5 5
     COUL turq LECT flui TERM
          vert LECT stru TERM
     EPAI 0.01 LECT stru TERM
GRIL LAGR LECT stru TERM
     EULE LECT flui TERM
MATE FLUT RO 1.0 EINT 2.5E5 GAMM 1.4 PB 0
          ITER 1 ALF0 1 BET0 1 KINT 0 AHGF 0 CL 0.5
          CQ 2.56 PMIN 0 NUM 1 PREF 1.E5
          LECT flui TERM
     VM23 RO 7800. YOUNG 1.6E11 NU 0.333 ELAS 1.05E8
          TRAC 2 1.05E8 .656256E-3 1.6105E10 1.00066
          LECT stru TERM
LINK COUP
     FSR  LECT fsrn TERM
     FLSR STRU LECT stru TERM
          FLUI LECT flui TERM
          R 0.2175 ! so that d = 2r = 0.435
          HGRI 1.6
          DGRI
          BFLU 0 FSCP 0
INIT VITE 1 100.0 LECT stru TERM
ECRI DEPL VITE ACCE FINT FEXT TFRE 10.E-3
          POIN LECT stru TERM
          ELEM LECT stru TERM
     FICH SPLI ALIC FREQ 1 !TFRE 1.E-3
OPTI NOTE
 CSTA 0.5 LOG 1 !dpma
 LNKS STAT
CALCUL TINI 0. TEND 100.D-3
FIN
```

fsia33a.epx

```
FSIA33A
ECHO
RESU SPLI ALIC 'fsia33.ali' GARD PSCR
COMP NGRO 1 'cs' LECT stru TERM COND NEAR POIN 1.5 5 5
SORT GRAP
PERF 'fsia33.pun'
AXTE 1.0 'Time [s]'
COUR 1 'dx_cs' DEPL COMP 1 NOEU LECT cs TERM
COUR 2 'vx_cs' VITE COMP 1 NOEU LECT cs TERM
TRAC 1 AXES 1.0 'DISPL. [M]'
TRAC 2 AXES 1.0 'VELOC. [M/S]'
LIST 1 AXES 1.0 'DISPL. [M]'
LIST 2 AXES 1.0 'VELOC. [M/S]'
*=================================================================
FIN
```

fsia33b.epx

```
FSIA33B
ECHO
RESU SPLI ALIC 'fsia33.ali' GARD PSCR
COMP GROU 1 'ygt5' LECT tous TERM COND YB GT 4.9
OPTI PRIN
SORT VISU NSTO 1
*=================================================================
PLAY
CAME   1 EYE   5.00000E+00 -3.68258E+01  1.62072E+01
!        Q     7.93353E-01  6.08761E-01  4.52854E-19  3.43977E-18
         VIEW -4.90654E-18  9.65926E-01 -2.58819E-01
         RIGH  1.00000E+00  6.00926E-18  3.46945E-18
         UP   -4.90654E-18  2.58819E-01  9.65926E-01
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  5.00000E+00  5.00000E+00  5.00000E+00
!RSPHERE:  8.66025E+00
!RADIUS :  4.33013E+01
!ASPECT :  1.00000E+00
!NEAR   :  3.37750E+01
!FAR    :  6.06218E+01
SCEN OBJE SELV FLSR
     GEOM NAVI FREE
     FACE HFRO
     LINE HEOU SSHA SFRE
     FLSR DOMA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 963 FPS 15 KFRE 10 COMP -1 REND
FREQ 1 !FREQ 0 TFRE 1.E-3
GOTR LOOP 961 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*=================================================================
FIN
```

fsia33compare.epx

```
FSIA33COMPARE
ECHO
RESU SPLI ALIC 'fsia33.ali' GARD PSCR
SORT GRAP
AXTE 1.0 'Time [s]'
RCOU 11 'dx_cs' FICH 'fsia31.pun' RENA 'dx_cs_31'
RCOU 12 'vx_cs' FICH 'fsia31.pun' RENA 'vx_cs_31'
RCOU 21 'dx_cs' FICH 'fsia32.pun' RENA 'dx_cs_32'
RCOU 22 'vx_cs' FICH 'fsia32.pun' RENA 'vx_cs_32'
RCOU 31 'dx_cs' FICH 'fsia33.pun' RENA 'dx_cs_33'
RCOU 32 'vx_cs' FICH 'fsia33.pun' RENA 'vx_cs_33'
RCOU 161 'dx_cs' FICH 'fsia26.pun' RENA 'dx_ps_26'
RCOU 162 'vx_cs' FICH 'fsia26.pun' RENA 'vx_ps_26'
!RCOU 191 'dx_pcs' FICH 'fsia19.pun' RENA 'dx_pcs_19'
!RCOU 192 'vx_pcs' FICH 'fsia19.pun' RENA 'vx_pcs_19'
!RCOU 141 'dx_pcs' FICH 'fsia14.pun' RENA 'dx_pcs_14' ! FE
!RCOU 142 'vx_pcs' FICH 'fsia14.pun' RENA 'vx_pcs_14' ! FE
TRAC 11 21 31 AXES 1.0 'DISPL. [M]'
COLO NOIR BLEU TURQ
TRAC 12 22 32 AXES 1.0 'VELOC. [M/S]'
COLO NOIR BLEU TURQ
TRAC 11 21 31 161 AXES 1.0 'DISPL. [M]'
COLO NOIR BLEU TURQ ROUG
TRAC 12 22 32 162 AXES 1.0 'VELOC. [M/S]'
COLO NOIR BLEU TURQ ROUG
!TRAC 41 191 AXES 1.0 'DISPL. [M]'
!COLO VERT ROUG
!TRAC 42 192 AXES 1.0 'VELOC. [M/S]'
!COLO VERT ROUG
TRAC 31 161 AXES 1.0 'DISPL. [M]'
COLO TURQ ROUG
TRAC 32 162 AXES 1.0 'VELOC. [M/S]'
COLO TURQ ROUG
*=================================================================
FIN
```

fsia33p.epx

```
FSIA33P
ECHO
RESU SPLI ALIC 'fsia33.ali' GARD PSCR
COMP GROU 1 'ygt5' LECT tous TERM COND YB GT 4.9
OPTI PRIN
SORT VISU NSTO 1
*=================================================================
PLAY
CAME   1 EYE   5.00000E+00 -3.68258E+01  1.62072E+01
!        Q     7.93353E-01  6.08761E-01  4.52854E-19  3.43977E-18
         VIEW -4.90654E-18  9.65926E-01 -2.58819E-01
         RIGH  1.00000E+00  6.00926E-18  3.46945E-18
         UP   -4.90654E-18  2.58819E-01  9.65926E-01
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  5.00000E+00  5.00000E+00  5.00000E+00
!RSPHERE:  8.66025E+00
!RADIUS :  4.33013E+01
!ASPECT :  1.00000E+00
!NEAR   :  3.37750E+01
!FAR    :  6.06218E+01
SCEN GEOM NAVI FREE
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 0.8E5 PAS 0.05E5 1.45E5 TERM
          SUPP LECT flui TERM
     TEXT ISCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 963 FPS 15 KFRE 10 COMP -1
     OBJE LECT ygt5 TERM REND
FREQ 1
GOTR LOOP 961 OFFS FICH AVI CONT NOCL
     OBJE LECT ygt5 TERM REND
GO
TRAC OFFS FICH AVI CONT
     OBJE LECT ygt5 TERM REND
ENDPLAY
*=================================================================
FIN
```

fsia33v.epx

```
FSIA33V
ECHO
RESU SPLI ALIC 'fsia33.ali' GARD PSCR
COMP GROU 1 'ygt5' LECT tous TERM COND YB GT 4.9
OPTI PRIN
SORT VISU NSTO 1
*=================================================================
PLAY
CAME   1 EYE   5.00000E+00 -3.68258E+01  1.62072E+01
!        Q     7.93353E-01  6.08761E-01  4.52854E-19  3.43977E-18
         VIEW -4.90654E-18  9.65926E-01 -2.58819E-01
         RIGH  1.00000E+00  6.00926E-18  3.46945E-18
         UP   -4.90654E-18  2.58819E-01  9.65926E-01
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  5.00000E+00  5.00000E+00  5.00000E+00
```

```
!RSPHERE:  8.66025E+00
!RADIUS :  4.33013E+01
!ASPECT :  1.00000E+00
!NEAR   :  3.37750E+01
!FAR    :  6.06218E+01
SCEN GEOM NAVI FREE
     FACE HFRO
     LINE HEOU SSHA SFRE
     VECT SCCO FIEL VITE SCAL USER PROG 10 PAS 10 140 TERM
          SIVE
     TEXT VSCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 963 FPS 15 KFRE 10 COMP -1
     OBJE LECT ygt5 TERM REND
FREQ 1
GOTR LOOP 961 OFFS FICH AVI CONT NOCL
     OBJE LECT ygt5 TERM REND
GO
TRAC OFFS FICH AVI CONT
     OBJE LECT ygt5 TERM REND
ENDPLAY
*=================================================================
FIN
```

fsia36.dgibi

```
opti echo 1;
opti dime 3 elem cub8;
opti titr 'FSIA36';
opti sauv form 'fsia36.msh';
opti trac psc ftra 'fsia36_mesh.ps';
p1 = 0 0 0;
p2 = 10 0 0;
p3 = 10 10 0;
p4 = 0 10 0;
pz = 0 0 10;
n = 10;
c1 = p1 d n p2;
c2 = p2 d n p3;
c3 = p3 d n p4;
c4 = p4 d n p1;
base = dall c1 c2 c3 c4 plan;
flui = base volu tran n pz;
fsrn = enve flui;
p1s = 1.5 1.5 1.5;
pcs = 1.5 5.5 1.5;
p2s = 1.5 8.5 1.5;
pzs = 0 0 7;
ns1 = 4;
ns2 = 3;
bstru = p1s d ns1 pcs d ns2 p2s;
stru = bstru tran (ns1+ns2) pzs;
mesh = flui et stru et fsrn;
tass mesh;
sauv form mesh;
trac mesh;
trac cach qual mesh;
fin;
```

fsia36.epx

```
FSIA36
ECHO
!CONV win
CAST mesh
TRID ALE
DIME
  ADAP NPOI 10000 CUVF 10000 NVFI 100000 ENDA
  NALE 1 NBLE 1
TERM
GEOM CUVF flui Q4GS stru TERM
COMP NGRO 1 'cs' LECT stru TERM COND NEAR POIN 1.5 5 5
     COUL turq LECT flui TERM
          vert LECT stru TERM
     EPAI 0.01 LECT stru TERM
GRIL LAGR LECT stru TERM
     EULE LECT flui TERM
MATE GAZP RO 1.0 GAMM 1.4 PINI 1.E5 PREF 1.E5
          LECT flui _cuvf TERM
     VM23 RO 7800. YOUNG 1.6E11 NU 0.333 ELAS 1.05E8
          TRAC 2 1.05E8 .656256E-3 1.6105E10 1.00066
          LECT stru TERM
LINK DECO
     FLSW STRU LECT stru TERM
          FLUI LECT flui TERM
          R 0.87 ! so that d = 2r = 1.74
          HGRI 1.6
          DGRI
          FACE
          BFLU 1 FSCP 0
          ADAP LMAX 3
INIT VITE 1 100.0 LECT stru TERM
ECRI DEPL VITE ACCE FINT FEXT VFCC TFRE 10.E-3
          POIN LECT stru TERM
          ELEM LECT stru TERM
     FICH SPLI ALIC FREQ 1 !TFRE 1.E-3
OPTI NOTE
 CSTA 0.5 LOG 1 !dpma
 LNKS STAT
 ADAP RCON
CALCUL TINI 0. TEND 100.D-3
FIN
```

fsia36a.epx

```
FSIA36A
ECHO
RESU SPLI ALIC 'fsia36.ali' GARD PSCR
COMP NGRO 1 'cs' LECT stru TERM COND NEAR POIN 1.5 5 5
SORT GRAP
PERF 'fsia36.pun'
AXTE 1.0 'Time [s]'
COUR 1 'dx_cs' DEPL COMP 1 NOEU LECT cs TERM
COUR 2 'vx_cs' VITE COMP 1 NOEU LECT cs TERM
TRAC 1 AXES 1.0 'DISPL. [M]'
TRAC 2 AXES 1.0 'VELOC. [M/S]'
LIST 1 AXES 1.0 'DISPL. [M]'
LIST 2 AXES 1.0 'VELOC. [M/S]'
*=================================================================
FIN
```

fsia36b.epx

```
FSIA36B
ECHO
RESU SPLI ALIC 'fsia36.ali' GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
*=================================================================
PLAY
CAME   1 EYE   5.00000E+00 -3.68258E+01  1.62072E+01
!        Q     7.93353E-01  6.08761E-01  4.52854E-19  3.43977E-18
         VIEW -4.90654E-18  9.65926E-01 -2.58819E-01
         RIGH  1.00000E+00  6.00926E-18  3.46945E-18
         UP   -4.90654E-18  2.58819E-01  9.65926E-01
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  5.00000E+00  5.00000E+00  5.00000E+00
!RSPHERE:  8.66025E+00
!RADIUS :  4.33013E+01
!ASPECT :  1.00000E+00
!NEAR   :  3.37750E+01
!FAR    :  6.06218E+01
SCEN OBJE !SELV FLSW
          !USLM LECT flui TERM DHAS CGLA
     GEOM NAVI FREE
          REFE BBOX
     FACE HFRO
     LINE HEOU SFRE
     FLSW DOMA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 963 FPS 15 KFRE 10 COMP -1 REND
FREQ 1 !FREQ 0 TFRE 1.E-3
GOTR LOOP 961 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*=================================================================
FIN
```

fsia36p.epx

```
FSIA36P
ECHO
RESU SPLI ALIC 'fsia36.ali' GARD PSCR
!COMP GROU 1 'ygt5' LECT tous TERM COND YB GT 4.9
OPTI PRIN
SORT VISU NSTO 1
*=================================================================
PLAY
CAME   1 EYE   5.00000E+00 -3.68258E+01  1.62072E+01
!        Q     7.93353E-01  6.08761E-01  4.52854E-19  3.43977E-18
         VIEW -4.90654E-18  9.65926E-01 -2.58819E-01
         RIGH  1.00000E+00  6.00926E-18  3.46945E-18
         UP   -4.90654E-18  2.58819E-01  9.65926E-01
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  5.00000E+00  5.00000E+00  5.00000E+00
!RSPHERE:  8.66025E+00
!RADIUS :  4.33013E+01
!ASPECT :  1.00000E+00
!NEAR   :  3.37750E+01
!FAR    :  6.06218E+01
SCEN GEOM NAVI FREE
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 0.8E5 PAS 0.05E5 1.45E5 TERM
          SUPP LECT flui TERM
     TEXT ISCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 963 FPS 15 KFRE 10 COMP -1
!    OBJE LECT ygt5 TERM REND
     REND
FREQ 1
GOTR LOOP 961 OFFS FICH AVI CONT NOCL
!    OBJE LECT ygt5 TERM REND
     REND
GO
TRAC OFFS FICH AVI CONT
!    OBJE LECT ygt5 TERM REND
     REND
ENDPLAY
*=================================================================
FIN
```

fsia36v.epx

```
FSIA36V
ECHO
RESU SPLI ALIC 'fsia36.ali' GARD PSCR
!COMP GROU 1 'ygt5' LECT tous TERM COND YB GT 4.9
OPTI PRIN
SORT VISU NSTO 1
*=================================================================
PLAY
CAME   1 EYE   5.00000E+00 -3.68258E+01  1.62072E+01
!        Q     7.93353E-01  6.08761E-01  4.52854E-19  3.43977E-18
         VIEW -4.90654E-18  9.65926E-01 -2.58819E-01
         RIGH  1.00000E+00  6.00926E-18  3.46945E-18
         UP   -4.90654E-18  2.58819E-01  9.65926E-01
         FOV   2.48819E+01
```

```
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  5.00000E+00  5.00000E+00  5.00000E+00
!RSPHERE:  8.66025E+00
!RADIUS :  4.33013E+01
!ASPECT :  1.00000E+00
!NEAR   :  3.37750E+01
!FAR    :  6.06218E+01
SCEN GEOM NAVI FREE
     FACE HFRO
     VECT SCCO FIEL VCVI SCAL USER PROG 10 PAS 10 140 TERM
          SUPP LECT flui TERM
          SIVE
     TEXT VSCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 963 FPS 15 KFRE 10 COMP -1
!    OBJE LECT ygt5 TERM REND
     REND
FREQ 1
GOTR LOOP 961 OFFS FICH AVI CONT NOCL
!    OBJE LECT ygt5 TERM REND
     REND
GO
TRAC OFFS FICH AVI CONT
!    OBJE LECT ygt5 TERM REND
     REND
ENDPLAY
*=================================================================
FIN
```

fsia41.dgibi

```
opti echo 1;
opti dime 3 elem cub8;
opti titr 'FSIA41';
opti sauv form 'fsia41.msh';
opti trac psc ftra 'fsia41_mesh.ps';
p1 = 0 0 0;
p2 = 10 0 0;
p3 = 10 10 0;
p4 = 0 10 0;
pz = 0 0 10;
n = 10;
c1 = p1 d n p2;
c2 = p2 d n p3;
c3 = p3 d n p4;
c4 = p4 d n p1;
base = dall c1 c2 c3 c4 plan;
flui = base volu tran n pz;
fsrn = enve flui;
p1s = 1.5 1.5 1.5;
pcs = 1.5 5.5 1.5;
p2s = 1.5 8.5 1.5;
pzs = 0 0 7;
ns1 = 4;
ns2 = 3;
bstru = p1s d ns1 pcs d ns2 p2s;
stru = bstru tran (ns1+ns2) pzs;
mesh = flui et stru et fsrn;
tass mesh;
sauv form mesh;
trac mesh;
trac cach qual mesh;
fin;
```

fsia41.epx

```
FSIA41
ECHO
!CONV win
CAST mesh
TRID ALE
DIME NALE 1 NBLE 1 TERM
GEOM CUVF flui Q4GS stru TERM
COMP NGRO 1 'cs' LECT stru TERM COND NEAR POIN 1.5 5 5
     COUL turq LECT flui TERM
          vert LECT stru TERM
     EPAI 0.01 LECT stru TERM
GRIL LAGR LECT stru TERM
     EULE LECT flui TERM
MATE GAZP RO 1.0 GAMM 1.4 PINI 1.E5 PREF 1.E5
          LECT flui TERM
     VM23 RO 7800. YOUNG 1.6E11 NU 0.333 ELAS 1.05E8
          TRAC 2 1.05E8 .656256E-3 1.6105E10 1.00066
          LECT stru TERM
LINK DECO
     FLSW STRU LECT stru TERM
          FLUI LECT flui TERM
          R 0.87 ! so that d = 2r = 1.74
          HGRI 1.6
          DGRI
          FACE
          BFLU 1 FSCP 0
INIT VITE 1 100.0 LECT stru TERM
ECRI DEPL VITE ACCE FINT FEXT VFCC TFRE 10.E-3
          POIN LECT stru TERM
          ELEM LECT stru TERM
     FICH ALIC FREQ 1 !TFRE 1.E-3
OPTI NOTE
 CSTA 0.5 LOG 1 !dpma
 LNKS STAT
CALCUL TINI 0. TEND 100.D-3
FIN
```

fsia41a.epx

```
FSIA41A
ECHO
RESU ALIC 'fsia41.ali' GARD PSCR
SORT GRAP
AXTE 1.0 'Time [s]'
COUR 1 'dx_cs' DEPL COMP 1 NOEU LECT cs TERM
COUR 2 'vx_cs' VITE COMP 1 NOEU LECT cs TERM
TRAC 1 AXES 1.0 'DISPL. [M]'
TRAC 2 AXES 1.0 'VELOC. [M/S]'
LIST 1 AXES 1.0 'DISPL. [M]'
LIST 2 AXES 1.0 'VELOC. [M/S]'
FIN
```

fsia41b.epx

```
FSIA41B
ECHO
RESU ALIC 'fsia41.ali' GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
*=================================================================
PLAY
CAME   1 EYE   5.00000E+00 -3.68258E+01  1.62072E+01
!        Q     7.93353E-01  6.08761E-01  4.52854E-19  3.43977E-18
         VIEW -4.90654E-18  9.65926E-01 -2.58819E-01
         RIGH  1.00000E+00  6.00926E-18  3.46945E-18
         UP   -4.90654E-18  2.58819E-01  9.65926E-01
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  5.00000E+00  5.00000E+00  5.00000E+00
!RSPHERE:  8.66025E+00
!RADIUS :  4.33013E+01
!ASPECT :  1.00000E+00
!NEAR   :  3.37750E+01
!FAR    :  6.06218E+01
SCEN OBJE SELV FLSW
     GEOM NAVI FREE
     FACE HFRO
     LINE HEOU SSHA SFRE
     FLSW DOMA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 964 FPS 15 KFRE 10 COMP -1 REND
FREQ 1 !FREQ 0 TFRE 1.E-3
GOTR LOOP 962 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*=================================================================
FIN
```

fsia41p.epx

```
FSIA41P
ECHO
RESU ALIC 'fsia41.ali' GARD PSCR
COMP GROU 1 'ygt5' LECT tous TERM COND YB GT 4.99
OPTI PRIN
SORT VISU NSTO 1
*=================================================================
PLAY
CAME   1 EYE   5.00000E+00 -3.68258E+01  1.62072E+01
!        Q     7.93353E-01  6.08761E-01  4.52854E-19  3.43977E-18
         VIEW -4.90654E-18  9.65926E-01 -2.58819E-01
         RIGH  1.00000E+00  6.00926E-18  3.46945E-18
         UP   -4.90654E-18  2.58819E-01  9.65926E-01
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  5.00000E+00  5.00000E+00  5.00000E+00
!RSPHERE:  8.66025E+00
!RADIUS :  4.33013E+01
!ASPECT :  1.00000E+00
!NEAR   :  3.37750E+01
!FAR    :  6.06218E+01
SCEN GEOM NAVI FREE
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 0.8E5 PAS 0.05E5 1.45E5 TERM
          SUPP LECT flui TERM
     TEXT ISCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 964 FPS 15 KFRE 10 COMP -1
     OBJE LECT ygt5 TERM REND
FREQ 1
GOTR LOOP 962 OFFS FICH AVI CONT NOCL
     OBJE LECT ygt5 TERM REND
GO
TRAC OFFS FICH AVI CONT
     OBJE LECT ygt5 TERM REND
ENDPLAY
*=================================================================
FIN
```

fsia41v.epx

```
FSIA41V
ECHO
RESU ALIC 'fsia41.ali' GARD PSCR
COMP GROU 1 'ygt5' LECT tous TERM COND YB GT 4.9
OPTI PRIN
SORT VISU NSTO 1
*=================================================================
PLAY
CAME   1 EYE   5.00000E+00 -3.68258E+01  1.62072E+01
!        Q     7.93353E-01  6.08761E-01  4.52854E-19  3.43977E-18
         VIEW -4.90654E-18  9.65926E-01 -2.58819E-01
         RIGH  1.00000E+00  6.00926E-18  3.46945E-18
         UP   -4.90654E-18  2.58819E-01  9.65926E-01
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  5.00000E+00  5.00000E+00  5.00000E+00
!RSPHERE:  8.66025E+00
!RADIUS :  4.33013E+01
!ASPECT :  1.00000E+00
!NEAR   :  3.37750E+01
!FAR    :  6.06218E+01
SCEN GEOM NAVI FREE
```

```
     FACE HFRO
     VECT SCCO FIEL VCVI SCAL USER PROG 10 PAS 10 140 TERM
          SUPP LECT FLUI TERM SIVE
     TEXT VSCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 964 FPS 15 KFRE 10 COMP -1
     OBJE LECT ygt5 TERM REND
FREQ 1
GOTR LOOP 962 OFFS FICH AVI CONT NOCL
     OBJE LECT ygt5 TERM REND
GO
TRAC OFFS FICH AVI CONT
     OBJE LECT ygt5 TERM REND
ENDPLAY
*=================================================================
FIN
```

fsia42.dgibi

```
opti echo 1;
opti dime 3 elem cub8;
opti titr 'FSIA42';
opti sauv form 'fsia42.msh';
opti trac psc ftra 'fsia42_mesh.ps';
p1 = 0 0 0;
p2 = 10 0 0;
p3 = 10 10 0;
p4 = 0 10 0;
pz = 0 0 10;
n = 20;
c1 = p1 d n p2;
c2 = p2 d n p3;
c3 = p3 d n p4;
c4 = p4 d n p1;
base = dall c1 c2 c3 c4 plan;
flui = base volu tran n pz;
fsrn = enve flui;
p1s = 1.5 1.5 1.5;
pcs = 1.5 5.5 1.5;
p2s = 1.5 8.5 1.5;
pzs = 0 0 7;
ns1 = 4;
ns2 = 3;
bstru = p1s d ns1 pcs d ns2 p2s;
stru = bstru tran (ns1+ns2) pzs;
mesh = flui et stru et fsrn;
tass mesh;
sauv form mesh;
trac mesh;
trac cach qual mesh;
fin;
```

fsia42.epx

```
FSIA42
ECHO
!CONV win
CAST mesh
TRID ALE
DIME NALE 1 NBLE 1 TERM
GEOM CUVF flui Q4GS stru TERM
COMP NGRO 1 'cs' LECT stru TERM COND NEAR POIN 1.5 5 5
     COUL turq LECT flui TERM
          vert LECT stru TERM
     EPAI 0.01 LECT stru TERM
GRIL LAGR LECT stru TERM
     EULE LECT flui TERM
MATE GAZP RO 1.0 GAMM 1.4 PINI 1.E5 PREF 1.E5
          LECT flui TERM
     VM23 RO 7800. YOUNG 1.6E11 NU 0.333 ELAS 1.05E8
          TRAC 2 1.05E8 .656256E-3 1.6105E10 1.00066
          LECT stru TERM
LINK DECO
     FLSW STRU LECT stru TERM
          FLUI LECT flui TERM
          R 0.435 ! so that d = 2r = 0.87
          HGRI 1.6
          DGRI
          FACE
          BFLU 1 FSCP 0
INIT VITE 1 100.0 LECT stru TERM
ECRI DEPL VITE ACCE FINT FEXT VFCC TFRE 10.E-3
          POIN LECT stru TERM
          ELEM LECT stru TERM
     FICH ALIC FREQ 1 !TFRE 1.E-3
OPTI NOTE
 CSTA 0.5 LOG 1 !dpma
 LNKS STAT
CALCUL TINI 0. TEND 100.D-3
FIN
```

fsia42a.epx

```
FSIA42A
ECHO
RESU ALIC 'fsia42.ali' GARD PSCR
SORT GRAP
AXTE 1.0 'Time [s]'
COUR 1 'dx_cs' DEPL COMP 1 NOEU LECT cs TERM
COUR 2 'vx_cs' VITE COMP 1 NOEU LECT cs TERM
TRAC 1 AXES 1.0 'DISPL. [M]'
TRAC 2 AXES 1.0 'VELOC. [M/S]'
LIST 1 AXES 1.0 'DISPL. [M]'
LIST 2 AXES 1.0 'VELOC. [M/S]'
FIN
```

fsia42b.epx

```
FSIA42B
ECHO
RESU ALIC 'fsia42.ali' GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
*=================================================================
PLAY
CAME   1 EYE   5.00000E+00 -3.68258E+01  1.62072E+01
!        Q     7.93353E-01  6.08761E-01  4.52854E-19  3.43977E-18
         VIEW -4.90654E-18  9.65926E-01 -2.58819E-01
         RIGH  1.00000E+00  6.00926E-18  3.46945E-18
         UP   -4.90654E-18  2.58819E-01  9.65926E-01
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  5.00000E+00  5.00000E+00  5.00000E+00
!RSPHERE:  8.66025E+00
!RADIUS :  4.33013E+01
!ASPECT :  1.00000E+00
!NEAR   :  3.37750E+01
!FAR    :  6.06218E+01
SCEN OBJE SELV FLSW
     GEOM NAVI FREE
     FACE HFRO
     LINE HEOU SSHA SFRE
     FLSW DOMA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 964 FPS 15 KFRE 10 COMP -1 REND
FREQ 1 !FREQ 0 TFRE 1.E-3
GOTR LOOP 962 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*=================================================================
FIN
```

fsia42p.epx

```
FSIA42P
ECHO
RESU ALIC 'fsia42.ali' GARD PSCR
COMP GROU 1 'ygt5' LECT tous TERM COND YB GT 4.99
OPTI PRIN
SORT VISU NSTO 1
*=================================================================
PLAY
CAME   1 EYE   5.00000E+00 -3.68258E+01  1.62072E+01
!        Q     7.93353E-01  6.08761E-01  4.52854E-19  3.43977E-18
         VIEW -4.90654E-18  9.65926E-01 -2.58819E-01
         RIGH  1.00000E+00  6.00926E-18  3.46945E-18
         UP   -4.90654E-18  2.58819E-01  9.65926E-01
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  5.00000E+00  5.00000E+00  5.00000E+00
!RSPHERE:  8.66025E+00
!RADIUS :  4.33013E+01
!ASPECT :  1.00000E+00
!NEAR   :  3.37750E+01
!FAR    :  6.06218E+01
SCEN GEOM NAVI FREE
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 0.8E5 PAS 0.05E5 1.45E5 TERM
          SUPP LECT flui TERM
     TEXT ISCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 964 FPS 15 KFRE 10 COMP -1
     OBJE LECT ygt5 TERM REND
FREQ 1
GOTR LOOP 962 OFFS FICH AVI CONT NOCL
     OBJE LECT ygt5 TERM REND
GO
TRAC OFFS FICH AVI CONT
     OBJE LECT ygt5 TERM REND
ENDPLAY
*=================================================================
FIN
```

fsia42v.epx

```
FSIA42V
ECHO
RESU ALIC 'fsia42.ali' GARD PSCR
COMP GROU 1 'ygt5' LECT tous TERM COND YB GT 4.9
OPTI PRIN
SORT VISU NSTO 1
*=================================================================
PLAY
CAME   1 EYE   5.00000E+00 -3.68258E+01  1.62072E+01
!        Q     7.93353E-01  6.08761E-01  4.52854E-19  3.43977E-18
         VIEW -4.90654E-18  9.65926E-01 -2.58819E-01
         RIGH  1.00000E+00  6.00926E-18  3.46945E-18
         UP   -4.90654E-18  2.58819E-01  9.65926E-01
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  5.00000E+00  5.00000E+00  5.00000E+00
!RSPHERE:  8.66025E+00
!RADIUS :  4.33013E+01
!ASPECT :  1.00000E+00
!NEAR   :  3.37750E+01
!FAR    :  6.06218E+01
SCEN GEOM NAVI FREE
     FACE HFRO
     VECT SCCO FIEL VCVI SCAL USER PROG 10 PAS 10 140 TERM
          SUPP LECT FLUI TERM SIVE
     TEXT VSCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 964 FPS 15 KFRE 10 COMP -1
     OBJE LECT ygt5 TERM REND
FREQ 1
```

```
GOTR LOOP 962 OFFS FICH AVI CONT NOCL
     OBJE LECT ygt5 TERM REND
GO
TRAC OFFS FICH AVI CONT
     OBJE LECT ygt5 TERM REND
ENDPLAY
*==================================================================
FIN
```

fsia43.dgibi

```
opti echo 1;
opti dime 3 elem cub8;
opti titr 'FSIA43';
opti sauv form 'fsia43.msh';
opti trac psc ftra 'fsia43_mesh.ps';
p1 = 0 0 0;
p2 = 10 0 0;
p3 = 10 10 0;
p4 = 0 10 0;
pz = 0 0 10;
n = 40;
c1 = p1 d n p2;
c2 = p2 d n p3;
c3 = p3 d n p4;
c4 = p4 d n p1;
base = dall c1 c2 c3 c4 plan;
flui = base volu tran n pz;
fsrn = enve flui;
p1s = 1.5 1.5 1.5;
pcs = 1.5 5.5 1.5;
p2s = 1.5 8.5 1.5;
pzs = 0 0 7;
ns1 = 4;
ns2 = 3;
bstru = p1s d ns1 pcs d ns2 p2s;
stru = bstru tran (ns1+ns2) pzs;
mesh = flui et stru et fsrn;
tass mesh;
sauv form mesh;
trac mesh;
trac cach qual mesh;
fin;
```

fsia43.epx

```
FSIA43
ECHO
!CONV win
CAST mesh
TRID ALE
DIME NALE 1 NBLE 1 TERM
GEOM CUVF flui Q4GS stru TERM
COMP NGRO 1 'cs' LECT stru TERM COND NEAR POIN 1.5 5 5
     COUL turq LECT flui TERM
          vert LECT stru TERM
     EPAI 0.01 LECT stru TERM
GRIL LAGR LECT stru TERM
     EULE LECT flui TERM
MATE GAZP RO 1.0 GAMM 1.4 PINI 1.E5 PREF 1.E5
          LECT flui TERM
     VM23 RO 7800. YOUNG 1.6E11 NU 0.333 ELAS 1.05E8
          TRAC 2 1.05E8 .656256E-3 1.6105E10 1.00066
          LECT stru TERM
LINK DECO
     FLSW STRU LECT stru TERM
          FLUI LECT flui TERM
          R 0.2175 ! so that d = 2r = 0.435
          HGRI 1.6
          DGRI
          FACE
          BFLU 1 FSCP 0
INIT VITE 1 100.0 LECT stru TERM
ECRI DEPL VITE ACCE FINT FEXT VFCC TFRE 10.E-3
          POIN LECT stru TERM
          ELEM LECT stru TERM
     FICH ALIC FREQ 1 !TFRE 1.E-3
OPTI NOTE
 CSTA 0.5 LOG 1 !dpma
 LNKS STAT
CALCUL TINI 0. TEND 100.D-3
FIN
```

fsia43a.epx

```
FSIA43A
ECHO
RESU ALIC 'fsia43.ali' GARD PSCR
SORT GRAP
AXTE 1.0 'Time [s]'
COUR 1 'dx_cs' DEPL COMP 1 NOEU LECT cs TERM
COUR 2 'vx_cs' VITE COMP 1 NOEU LECT cs TERM
TRAC 1 AXES 1.0 'DISPL. [M]'
TRAC 2 AXES 1.0 'VELOC. [M/S]'
LIST 1 AXES 1.0 'DISPL. [M]'
LIST 2 AXES 1.0 'VELOC. [M/S]'
FIN
```

fsia43b.epx

```
FSIA43B
ECHO
RESU ALIC 'fsia43.ali' GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
*==================================================================
PLAY
CAME   1 EYE   5.00000E+00 -3.68258E+01  1.62072E+01
!        Q     7.93353E-01  6.08761E-01  4.52854E-19  3.43977E-18
         VIEW -4.90654E-18  9.65926E-01 -2.58819E-01
         RIGH  1.00000E+00  6.00926E-18  3.46945E-18
         UP   -4.90654E-18  2.58819E-01  9.65926E-01
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  5.00000E+00  5.00000E+00  5.00000E+00
!RSPHERE:  8.66025E+00
!RADIUS :  4.33013E+01
!ASPECT :  1.00000E+00
!NEAR   :  3.37750E+01
!FAR    :  6.06218E+01
SCEN OBJE SELV FLSW
     GEOM NAVI FREE
     FACE HFRO
     LINE HEOU SSHA SFRE
     FLSW DOMA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 963 FPS 15 KFRE 10 COMP -1 REND
FREQ 1 !FREQ 0 TFRE 1.E-3
GOTR LOOP 961 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*==================================================================
FIN
```

fsia43p.epx

```
FSIA43P
ECHO
RESU ALIC 'fsia43.ali' GARD PSCR
COMP GROU 1 'ygt5' LECT tous TERM COND YB GT 4.99
OPTI PRIN
SORT VISU NSTO 1
*==================================================================
PLAY
CAME   1 EYE   5.00000E+00 -3.68258E+01  1.62072E+01
!        Q     7.93353E-01  6.08761E-01  4.52854E-19  3.43977E-18
         VIEW -4.90654E-18  9.65926E-01 -2.58819E-01
         RIGH  1.00000E+00  6.00926E-18  3.46945E-18
         UP   -4.90654E-18  2.58819E-01  9.65926E-01
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  5.00000E+00  5.00000E+00  5.00000E+00
!RSPHERE:  8.66025E+00
!RADIUS :  4.33013E+01
!ASPECT :  1.00000E+00
!NEAR   :  3.37750E+01
!FAR    :  6.06218E+01
SCEN GEOM NAVI FREE
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 0.8E5 PAS 0.05E5 1.45E5 TERM
          SUPP LECT flui TERM
     TEXT ISCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 963 FPS 15 KFRE 10 COMP -1
     OBJE LECT ygt5 TERM REND
FREQ 1
GOTR LOOP 961 OFFS FICH AVI CONT NOCL
     OBJE LECT ygt5 TERM REND
GO
TRAC OFFS FICH AVI CONT
     OBJE LECT ygt5 TERM REND
ENDPLAY
*==================================================================
FIN
```

fsia43v.epx

```
FSIA43V
ECHO
RESU ALIC 'fsia43.ali' GARD PSCR
COMP GROU 1 'ygt5' LECT tous TERM COND YB GT 4.9
OPTI PRIN
SORT VISU NSTO 1
*==================================================================
PLAY
CAME   1 EYE   5.00000E+00 -3.68258E+01  1.62072E+01
!        Q     7.93353E-01  6.08761E-01  4.52854E-19  3.43977E-18
         VIEW -4.90654E-18  9.65926E-01 -2.58819E-01
         RIGH  1.00000E+00  6.00926E-18  3.46945E-18
         UP   -4.90654E-18  2.58819E-01  9.65926E-01
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  5.00000E+00  5.00000E+00  5.00000E+00
!RSPHERE:  8.66025E+00
!RADIUS :  4.33013E+01
!ASPECT :  1.00000E+00
!NEAR   :  3.37750E+01
!FAR    :  6.06218E+01
SCEN GEOM NAVI FREE
     FACE HFRO
     LINE HEOU SSHA SFRE
     VECT SCCO FIEL VCVI SCAL USER PROG 10 PAS 10 140 TERM
          SUPP LECT FLUI TERM SIVE
     TEXT VSCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 963 FPS 15 KFRE 10 COMP -1
     OBJE LECT ygt5 TERM REND
FREQ 1
GOTR LOOP 961 OFFS FICH AVI CONT NOCL
     OBJE LECT ygt5 TERM REND
GO
TRAC OFFS FICH AVI CONT
     OBJE LECT ygt5 TERM REND
ENDPLAY
*==================================================================
FIN
```

mill04.epx

```
MILL04
ECHO
!CONV win
DPLA ALE
DIME
  ADAP NPOI 1228 FL24 1424 ENDA
  NALE 1 NBLE 1
TERM
GEOM LIBR POIN 138 FL24 100 ED01 16 TERM
 0 0  1 0  2 0  3 0  4 0  5 0  6 0  7 0  8 0  9 0  10 0
 0 1  1 1  2 1  3 1  4 1  5 1  6 1  7 1  8 1  9 1  10 1
 0 2  1 2  2 2  3 2  4 2  5 2  6 2  7 2  8 2  9 2  10 2
 0 3  1 3  2 3  3 3  4 3  5 3  6 3  7 3  8 3  9 3  10 3
 0 4  1 4  2 4  3 4  4 4  5 4  6 4  7 4  8 4  9 4  10 4
 0 5  1 5  2 5  3 5  4 5  5 5  6 5  7 5  8 5  9 5  10 5
 0 6  1 6  2 6  3 6  4 6  5 6  6 6  7 6  8 6  9 6  10 6
 0 7  1 7  2 7  3 7  4 7  5 7  6 7  7 7  8 7  9 7  10 7
 0 8  1 8  2 8  3 8  4 8  5 8  6 8  7 8  8 8  9 8  10 8
 0 9  1 9  2 9  3 9  4 9  5 9  6 9  7 9  8 9  9 9  10 9
 0 10  1 10  2 10  3 10  4 10  5 10  6 10  7 10  8 10  9 10  10 10
 5 1 5 2 5 3 5 4 5 5 5 6 5 7 5 8 5 9
 1 5 2 5 3 5 4 5 6 5 7 5 8 5 9 5
 1 2 13 12   2 3 14 13   3 4 15 14   4 5 16 15   5 6 17 16
 6 7 18 17   7 8 19 18   8 9 20 19   9 10 21 20  10 11 22 21
 12 13 24 23 13 14 25 24 14 15 26 25 15 16 27 26 16 17 28 27
 17 18 29 28 18 19 30 29 19 20 31 30 20 21 32 31 21 22 33 32
 23 24 35 34 24 25 36 35 25 26 37 36 26 27 38 37 27 28 39 38
 28 29 40 39 29 30 41 40 30 31 42 41 31 32 43 42 32 33 44 43
 34 35 46 45 35 36 47 46 36 37 48 47 37 38 49 48 38 39 50 49
 39 40 51 50 40 41 52 51 41 42 53 52 42 43 54 53 43 44 55 54
 45 46 57 56 46 47 58 57 47 48 59 58 48 49 60 59 49 50 61 60
 50 51 62 61 51 52 63 62 52 53 64 63 53 54 65 64 54 55 66 65
 56 57 68 67 57 58 69 68 58 59 70 69 59 60 71 70 60 61 72 71
 61 62 73 72 62 63 74 73 63 64 75 74 64 65 76 75 65 66 77 76
 67 68 79 78 68 69 80 79 69 70 81 80 70 71 82 81 71 72 83 82
 72 73 84 83 73 74 85 84 74 75 86 85 75 76 87 86 76 77 88 87
 78 79 90 89 79 80 91 90 80 81 92 91 81 82 93 92 82 83 94 93
 83 84 95 94 84 85 96 95 85 86 97 96 86 87 98 97 87 88 99 98
 89 90 101 100 90 91 102 101 91 92 103 102 92 93 104 103
 93 94 105 104 94 95 106 105 95 96 107 106 96 97 108 107
 97 98 109 108 98 99 110 109
 100 101 112 111 101 102 113 112 102 103 114 113 103 104 115 114
 104 105 116 115 105 106 117 116 106 107 118 117 107 108 119 118
 108 109 120 119 109 110 121 120
 122 123  123 124  124 125  125 126  126 127  127 128  128 129  129 130
 131 132  132 133  133 134  134 126  126 135  135 136  136 137  137 138
COMP GROU 2 'flui' LECT 1 PAS 1 100 TERM
            'stru' LECT 101 PAS 1 116 TERM
     NGRO 2 'blox' LECT 1 PAS 11 111 11 PAS 11 121 TERM
            'bloy' LECT 1 PAS 1 11 111 PAS 1 121 TERM
     COUL turq LECT flui TERM
          vert LECT stru TERM
     EPAI 0.01 LECT stru TERM
GRIL LAGR LECT stru TERM
     EULE LECT flui TERM
MATE FLUT RO 1.0 EINT 2.5E5 GAMM 1.4 PB 0
          ITER 1 ALF0 1 BET0 1 KINT 0 AHGF 0 CL 0.5
          CQ 2.56 PMIN 0 NUM 1 PREF 1.E5
          LECT flui _fl24 TERM
     VM23 RO 7800. YOUNG 1.6E11 NU 0.333 ELAS 1.05E8
          TRAC 2 1.05E8 .656256E-3 1.6105E10 1.00066
          LECT stru TERM
LINK COUP
     BLOQ 1 LECT blox TERM
     BLOQ 2 LECT bloy TERM
     BLOQ 12 LECT 126 TERM
     FLSR STRU LECT stru TERM
          FLUI LECT flui TERM
          R 0.7072 ! so that d = 2r = 1.4144
          HGRI 1.6
          DGRI
         !BFLU 0 FSCP 1
          BFLU 0 FSCP 0
          ADAP LMAX 4 SCAL 2.0
INIT VITE 1  -80.0 LECT 122 TERM
          1  -60.0 LECT 123 TERM
          1  -40.0 LECT 124 TERM
          1  -20.0 LECT 125 TERM
          1   20.0 LECT 127 TERM
          1   40.0 LECT 128 TERM
          1   60.0 LECT 129 TERM
          1   80.0 LECT 130 TERM
          2   80.0 LECT 131 TERM
          2   60.0 LECT 132 TERM
          2   40.0 LECT 133 TERM
          2   20.0 LECT 134 TERM
          2  -20.0 LECT 135 TERM
          2  -40.0 LECT 136 TERM
          2  -60.0 LECT 137 TERM
          2  -80.0 LECT 138 TERM
ECRI DEPL VITE ACCE FINT FEXT TFRE 10.E-3
          POIN LECT stru TERM
          ELEM LECT stru TERM
     FICH ALIC FREQ 1 !TFRE 1.E-3
OPTI NOTE
 CSTA 0.5 LOG 1 !dpma
 LNKS STAT
!ADAP RCON
CALCUL TINI 0. TEND 100.D-3
*=================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
SCEN OBJE SELV FLSR
     GEOM NAVI FREE
     FACE HFRO
     FLSR DOMA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 963 FPS 15 KFRE 10 COMP -1 REND
FREQ 1 !FREQ 0 TFRE 1.E-3
GOTR LOOP 961 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*=================================================================
SUIT
Post-treatment
ECHO
RESU ALIC GARD PSCR
SORT GRAP
AXTE 1.0 'Time [s]'
COUR 1 'dx_130' DEPL COMP 1 NOEU LECT 130 TERM
COUR 2 'vx_130' VITE COMP 1 NOEU LECT 130 TERM
TRAC 1 AXES 1.0 'DISPL. [M]'
TRAC 2 AXES 1.0 'VELOC. [M/S]'
LIST 1 AXES 1.0 'DISPL. [M]'
LIST 2 AXES 1.0 'VELOC. [M/S]'
*=================================================================
FIN
```

mill04p.epx

```
MILL04P
ECHO
RESU ALIC 'mill04.ali' GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
*=================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
SCEN GEOM NAVI FREE
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 0.8E5 PAS 0.02E5 1.06E5 TERM
          SUPP LECT flui TERM
     TEXT ISCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 963 FPS 15 KFRE 10 COMP -1 REND
FREQ 1
GOTR LOOP 961 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*=================================================================
FIN
```

mill04v.epx

```
MILL04V
ECHO
RESU ALIC 'mill04.ali' GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
*=================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
SCEN GEOM NAVI FREE
     FACE HFRO
     VECT SCCO FIEL VITE SCAL USER PROG 10 PAS 10 140 TERM
     TEXT VSCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 963 FPS 15 KFRE 10 COMP -1 REND
FREQ 1
GOTR LOOP 961 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*=================================================================
FIN
```

mill11.dgibi

```
opti echo 1;
opti dime 2 elem qua4;
opti titr 'MILL11';
opti sauv form 'mill11.msh';
opti trac psc ftra 'mill11_mesh.ps';
p1 = 0 0;
p2 = 10 0;
p3 = 10 10;
p4 = 0 10;
n = 10;
c1 = p1 d n p2;
c2 = p2 d n p3;
c3 = p3 d n p4;
c4 = p4 d n p1;
flui = dall c1 c2 c3 c4 plan;
p122s = 5 1;
p123s = 5 2;
p124s = 5 3;
p125s = 5 4;
p126s = 5 5;
p127s = 5 6;
p128s = 5 7;
p129s = 5 8;
p130s = 5 9;
p131s = 1 5;
p132s = 2 5;
p133s = 3 5;
p134s = 4 5;
```

```
p135s = 6 5;
p136s = 7 5;
p137s = 8 5;
p138s = 9 5;
stru1 = p122s d 1 p123s d 1 p124s d 1 p125s d 1 p126s d 1 p127s
              d 1 p128s d 1 p129s d 1 p130s;
stru2 = p131s d 1 p132s d 1 p133s d 1 p134s d 1 p126s d 1 p135s
              d 1 p136s d 1 p137s d 1 p138s;
stru = stru1 et stru2;
mesh = flui et stru;
tass mesh;
sauv form mesh;
trac qual mesh;
fin;
```

mill11.epx

```
MILL11
ECHO
!CONV win
CAST mesh
DPLA ALE
DIME NALE 1 NBLE 1 TERM
GEOM FL24 flui ED01 stru TERM
COMP NGRO 2 'blox' LECT c2 c4 TERM
            'bloy' LECT c1 c3 TERM
     COUL turq LECT flui TERM
          vert LECT stru TERM
     EPAI 0.01 LECT stru TERM
GRIL LAGR LECT stru TERM
     EULE LECT flui TERM
MATE FLUT RO 1.0 EINT 2.5E5 GAMM 1.4 PB 0
          ITER 1 ALF0 1 BET0 1 KINT 0 AHGF 0 CL 0.5
          CQ 2.56 PMIN 0 NUM 1 PREF 1.E5
          LECT flui TERM
     VM23 RO 7800. YOUNG 1.6E11 NU 0.333 ELAS 1.05E8
          TRAC 2 1.05E8 .656256E-3 1.6105E10 1.00066
          LECT stru TERM
LINK COUP
     BLOQ 1 LECT blox TERM
     BLOQ 2 LECT bloy TERM
     BLOQ 12 LECT p126s TERM
     FLSR STRU LECT stru TERM
          FLUI LECT flui TERM
          R 0.7072 ! so that d = 2r = 1.4144
          HGRI 1.6
          DGRI
         !BFLU 0 FSCP 1
          BFLU 0 FSCP 0
INIT VITE 1  -80.0 LECT p122s TERM
          1  -60.0 LECT p123s TERM
          1  -40.0 LECT p124s TERM
          1  -20.0 LECT p125s TERM
          1   20.0 LECT p127s TERM
          1   40.0 LECT p128s TERM
          1   60.0 LECT p129s TERM
          1   80.0 LECT p130s TERM
          2   80.0 LECT p131s TERM
          2   60.0 LECT p132s TERM
          2   40.0 LECT p133s TERM
          2   20.0 LECT p134s TERM
          2  -20.0 LECT p135s TERM
          2  -40.0 LECT p136s TERM
          2  -60.0 LECT p137s TERM
          2  -80.0 LECT p138s TERM
ECRI DEPL VITE ACCE FINT FEXT TFRE 10.E-3
          POIN LECT stru TERM
          ELEM LECT stru TERM
     FICH ALIC FREQ 1 !TFRE 1.E-3
OPTI NOTE
 CSTA 0.5 LOG 1 !dpma
 LNKS STAT
CALCUL TINI 0. TEND 100.D-3
*=================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
!        Q      1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
SCEN OBJE SELV FLSR
     GEOM NAVI FREE
     FACE HFRO
     FLSR DOMA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 962 FPS 15 KFRE 10 COMP -1 REND
FREQ 1 !FREQ 0 TFRE 1.E-3
GOTR LOOP 960 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*=================================================================
SUIT
Post-treatment
ECHO
RESU ALIC GARD PSCR
SORT GRAP
AXTE 1.0 'Time [s]'
COUR 1 'dx_130' DEPL COMP 1 NOEU LECT p130s TERM
COUR 2 'vx_130' VITE COMP 1 NOEU LECT p130s TERM
TRAC 1 AXES 1.0 'DISPL. [M]'
TRAC 2 AXES 1.0 'VELOC. [M/S]'
LIST 1 AXES 1.0 'DISPL. [M]'
LIST 2 AXES 1.0 'VELOC. [M/S]'
*=================================================================
FIN
```

mill11p.epx

```
MILL11P
ECHO
RESU ALIC 'mill11.ali' GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
*=================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
!        Q      1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
SCEN GEOM NAVI FREE
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 0.8E5 PAS 0.02E5 1.06E5 TERM
          SUPP LECT flui TERM
     TEXT ISCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 962 FPS 15 KFRE 10 COMP -1 REND
FREQ 1
GOTR LOOP 960 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*=================================================================
FIN
```

mill11v.epx

```
MILL11V
ECHO
RESU ALIC 'mill11.ali' GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
*=================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
!        Q      1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
SCEN GEOM NAVI FREE
     FACE HFRO
     VECT SCCO FIEL VITE SCAL USER PROG 10 PAS 10 140 TERM
     TEXT VSCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 962 FPS 15 KFRE 10 COMP -1 REND
FREQ 1
GOTR LOOP 960 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*=================================================================
FIN
```

mill12.dgibi

```
opti echo 1;
opti dime 2 elem qua4;
opti titr 'MILL12';
opti sauv form 'mill12.msh';
opti trac psc ftra 'mill12_mesh.ps';
p1 = 0 0;
p2 = 10 0;
p3 = 10 10;
p4 = 0 10;
n = 20;
c1 = p1 d n p2;
c2 = p2 d n p3;
c3 = p3 d n p4;
c4 = p4 d n p1;
flui = dall c1 c2 c3 c4 plan;
p122s = 5 1;
p123s = 5 2;
p124s = 5 3;
p125s = 5 4;
p126s = 5 5;
p127s = 5 6;
p128s = 5 7;
p129s = 5 8;
p130s = 5 9;
p131s = 1 5;
p132s = 2 5;
p133s = 3 5;
p134s = 4 5;
p135s = 6 5;
p136s = 7 5;
p137s = 8 5;
p138s = 9 5;
stru1 = p122s d 1 p123s d 1 p124s d 1 p125s d 1 p126s d 1 p127s
              d 1 p128s d 1 p129s d 1 p130s;
stru2 = p131s d 1 p132s d 1 p133s d 1 p134s d 1 p126s d 1 p135s
              d 1 p136s d 1 p137s d 1 p138s;
stru = stru1 et stru2;
mesh = flui et stru;
tass mesh;
sauv form mesh;
trac qual mesh;
fin;
```

mill12.epx

```
MILL12
ECHO
!CONV win
CAST mesh
DPLA ALE
DIME NALE 1 NBLE 1 TERM
GEOM FL24 flui ED01 stru TERM
COMP NGRO 2 'blox' LECT c2 c4 TERM
```

```
          'bloy' LECT c1 c3 TERM
     COUL turq LECT flui TERM
          vert LECT stru TERM
     EPAI 0.01 LECT stru TERM
GRIL LAGR LECT stru TERM
     EULE LECT flui TERM
MATE FLUT RO 1.0 EINT 2.5E5 GAMM 1.4 PB 0
          ITER 1 ALF0 1 BET0 1 KINT 0 AHGF 0 CL 0.5
          CQ 2.56 PMIN 0 NUM 1 PREF 1.E5
          LECT flui TERM
     VM23 RO 7800. YOUNG 1.6E11 NU 0.333 ELAS 1.05E8
          TRAC 2 1.05E8 .656256E-3 1.6105E10 1.00066
          LECT stru TERM
LINK COUP
     BLOQ 1 LECT blox TERM
     BLOQ 2 LECT bloy TERM
     BLOQ 12 LECT p126s TERM
     FLSR STRU LECT stru TERM
          FLUI LECT flui TERM
          R 0.3536 ! so that d = 2r = 0.7072
          HGRI 1.6
          DGRI
         !BFLU 0 FSCP 1
          BFLU 0 FSCP 0
INIT VITE 1  -80.0 LECT p122s TERM
          1  -60.0 LECT p123s TERM
          1  -40.0 LECT p124s TERM
          1  -20.0 LECT p125s TERM
          1   20.0 LECT p127s TERM
          1   40.0 LECT p128s TERM
          1   60.0 LECT p129s TERM
          1   80.0 LECT p130s TERM
          2   80.0 LECT p131s TERM
          2   60.0 LECT p132s TERM
          2   40.0 LECT p133s TERM
          2   20.0 LECT p134s TERM
          2  -20.0 LECT p135s TERM
          2  -40.0 LECT p136s TERM
          2  -60.0 LECT p137s TERM
          2  -80.0 LECT p138s TERM
ECRI DEPL VITE ACCE FINT FEXT TFRE 10.E-3
          POIN LECT stru TERM
          ELEM LECT stru TERM
     FICH ALIC FREQ 1 !TFRE 1.E-3
OPTI NOTE
 CSTA 0.5 LOG 1 !dpma
 LNKS STAT
CALCUL TINI 0. TEND 100.D-3
*================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
SCEN OBJE SELV FLSR
     GEOM NAVI FREE
     FACE HFRO
     FLSR DOMA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 962 FPS 15 KFRE 10 COMP -1 REND
FREQ 1 !FREQ 0 TFRE 1.E-3
GOTR LOOP 960 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*================================================================
SUIT
Post-treatment
ECHO
RESU ALIC GARD PSCR
SORT GRAP
AXTE 1.0 'Time [s]'
COUR 1 'dx_130' DEPL COMP 1 NOEU LECT p130s TERM
COUR 2 'vx_130' VITE COMP 1 NOEU LECT p130s TERM
TRAC 1 AXES 1.0 'DISPL. [M]'
TRAC 2 AXES 1.0 'VELOC. [M/S]'
LIST 1 AXES 1.0 'DISPL. [M]'
LIST 2 AXES 1.0 'VELOC. [M/S]'
*================================================================
FIN
```

mill12p.epx

```
MILL12P
ECHO
RESU ALIC 'mill12.ali' GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
*================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
SCEN GEOM NAVI FREE
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 0.8E5 PAS 0.02E5 1.06E5 TERM
          SUPP LECT flui TERM
     TEXT ISCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 962 FPS 15 KFRE 10 COMP -1 REND
FREQ 1
GOTR LOOP 960 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*================================================================
FIN
```

mill12v.epx

```
MILL12V
ECHO
RESU ALIC 'mill12.ali' GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
*================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
SCEN GEOM NAVI FREE
     FACE HFRO
     VECT SCCO FIEL VITE SCAL USER PROG 10 PAS 10 140 TERM
     TEXT VSCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 962 FPS 15 KFRE 10 COMP -1 REND
FREQ 1
GOTR LOOP 960 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*================================================================
FIN
```

mill13.dgibi

```
opti echo 1;
opti dime 2 elem qua4;
opti titr 'MILL13';
opti sauv form 'mill13.msh';
opti trac psc ftra 'mill13_mesh.ps';
p1 = 0 0;
p2 = 10 0;
p3 = 10 10;
p4 = 0 10;
n = 40;
c1 = p1 d n p2;
c2 = p2 d n p3;
c3 = p3 d n p4;
c4 = p4 d n p1;
flui = dall c1 c2 c3 c4 plan;
p122s = 5 1;
p123s = 5 2;
p124s = 5 3;
p125s = 5 4;
p126s = 5 5;
p127s = 5 6;
p128s = 5 7;
p129s = 5 8;
p130s = 5 9;
p131s = 1 5;
p132s = 2 5;
p133s = 3 5;
p134s = 4 5;
p135s = 6 5;
p136s = 7 5;
p137s = 8 5;
p138s = 9 5;
stru1 = p122s d 1 p123s d 1 p124s d 1 p125s d 1 p126s d 1 p127s
               d 1 p128s d 1 p129s d 1 p130s;
stru2 = p131s d 1 p132s d 1 p133s d 1 p134s d 1 p126s d 1 p135s
               d 1 p136s d 1 p137s d 1 p138s;
stru = stru1 et stru2;
mesh = flui et stru;
tass mesh;
sauv form mesh;
trac qual mesh;
fin;
```

mill13.epx

```
MILL13
ECHO
!CONV win
CAST mesh
DPLA ALE
DIME NALE 1 NBLE 1 TERM
GEOM FL24 flui ED01 stru TERM
COMP NGRO 2 'blox' LECT c2 c4 TERM
            'bloy' LECT c1 c3 TERM
     COUL turq LECT flui TERM
          vert LECT stru TERM
     EPAI 0.01 LECT stru TERM
GRIL LAGR LECT stru TERM
     EULE LECT flui TERM
MATE FLUT RO 1.0 EINT 2.5E5 GAMM 1.4 PB 0
          ITER 1 ALF0 1 BET0 1 KINT 0 AHGF 0 CL 0.5
          CQ 2.56 PMIN 0 NUM 1 PREF 1.E5
          LECT flui TERM
     VM23 RO 7800. YOUNG 1.6E11 NU 0.333 ELAS 1.05E8
          TRAC 2 1.05E8 .656256E-3 1.6105E10 1.00066
          LECT stru TERM
LINK COUP
     BLOQ 1 LECT blox TERM
     BLOQ 2 LECT bloy TERM
     BLOQ 12 LECT p126s TERM
     FLSR STRU LECT stru TERM
          FLUI LECT flui TERM
          R 0.1768 ! so that d = 2r = 0.3536
          HGRI 1.6
          DGRI
         !BFLU 0 FSCP 1
          BFLU 0 FSCP 0
INIT VITE 1  -80.0 LECT p122s TERM
          1  -60.0 LECT p123s TERM
          1  -40.0 LECT p124s TERM
```

```
          1  -20.0 LECT p125s TERM
          1   20.0 LECT p127s TERM
          1   40.0 LECT p128s TERM
          1   60.0 LECT p129s TERM
          1   80.0 LECT p130s TERM
          2   80.0 LECT p131s TERM
          2   60.0 LECT p132s TERM
          2   40.0 LECT p133s TERM
          2   20.0 LECT p134s TERM
          2  -20.0 LECT p135s TERM
          2  -40.0 LECT p136s TERM
          2  -60.0 LECT p137s TERM
          2  -80.0 LECT p138s TERM
ECRI DEPL VITE ACCE FINT FEXT TFRE 10.E-3
          POIN LECT stru TERM
          ELEM LECT stru TERM
     FICH ALIC FREQ 1 !TFRE 1.E-3
OPTI NOTE
 CSTA 0.5 LOG 1 !dpma
 LNKS STAT
CALCUL TINI 0. TEND 100.D-3
*=================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
!        Q      1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
SCEN OBJE SELV FLSR
     GEOM NAVI FREE
     FACE HFRO
     FLSR DOMA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 962 FPS 15 KFRE 10 COMP -1 REND
FREQ 1 !FREQ 0 TFRE 1.E-3
GOTR LOOP 960 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*=================================================================
SUIT
Post-treatment
ECHO
RESU ALIC GARD PSCR
SORT GRAP
AXTE 1.0 'Time [s]'
COUR 1 'dx_130' DEPL COMP 1 NOEU LECT p130s TERM
COUR 2 'vx_130' VITE COMP 1 NOEU LECT p130s TERM
TRAC 1 AXES 1.0 'DISPL. [M]'
TRAC 2 AXES 1.0 'VELOC. [M/S]'
LIST 1 AXES 1.0 'DISPL. [M]'
LIST 2 AXES 1.0 'VELOC. [M/S]'
*=================================================================
FIN
```

mill13p.epx

```
MILL13P
ECHO
RESU ALIC 'mill13.ali' GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
*=================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
!        Q      1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
SCEN GEOM NAVI FREE
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 0.8E5 PAS 0.02E5 1.06E5 TERM
          SUPP LECT flui TERM
     TEXT ISCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 962 FPS 15 KFRE 10 COMP -1 REND
FREQ 1
GOTR LOOP 960 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*=================================================================
FIN
```

mill13v.epx

```
MILL13V
ECHO
RESU ALIC 'mill13.ali' GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
*=================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
!        Q      1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
SCEN GEOM NAVI FREE
     FACE HFRO
     VECT SCCO FIEL VITE SCAL USER PROG 10 PAS 10 140 TERM
     TEXT VSCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 962 FPS 15 KFRE 10 COMP -1 REND
FREQ 1
GOTR LOOP 960 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*=================================================================
FIN
```

mill14.dgibi

```
opti echo 1;
opti dime 2 elem qua4;
opti titr 'MILL14';
opti sauv form 'mill14.msh';
opti trac psc ftra 'mill14_mesh.ps';
p1 = 0 0;
p2 = 10 0;
p3 = 10 10;
p4 = 0 10;
n = 80;
c1 = p1 d n p2;
c2 = p2 d n p3;
c3 = p3 d n p4;
c4 = p4 d n p1;
flui = dall c1 c2 c3 c4 plan;
p122s = 5 1;
p123s = 5 2;
p124s = 5 3;
p125s = 5 4;
p126s = 5 5;
p127s = 5 6;
p128s = 5 7;
p129s = 5 8;
p130s = 5 9;
p131s = 1 5;
p132s = 2 5;
p133s = 3 5;
p134s = 4 5;
p135s = 6 5;
p136s = 7 5;
p137s = 8 5;
p138s = 9 5;
stru1 = p122s d 1 p123s d 1 p124s d 1 p125s d 1 p126s d 1 p127s
            d 1 p128s d 1 p129s d 1 p130s;
stru2 = p131s d 1 p132s d 1 p133s d 1 p134s d 1 p126s d 1 p135s
            d 1 p136s d 1 p137s d 1 p138s;
stru = stru1 et stru2;
mesh = flui et stru;
tass mesh;
sauv form mesh;
trac qual mesh;
fin;
```

mill14.epx

```
MILL14
ECHO
!CONV win
CAST mesh
DPLA ALE
DIME NALE 1 NBLE 1 TERM
GEOM FL24 flui ED01 stru TERM
COMP NGRO 2 'blox' LECT c2 c4 TERM
            'bloy' LECT c1 c3 TERM
     COUL turq LECT flui TERM
          vert LECT stru TERM
     EPAI 0.01 LECT stru TERM
GRIL LAGR LECT stru TERM
     EULE LECT flui TERM
MATE FLUT RO 1.0 EINT 2.5E5 GAMM 1.4 PB 0
          ITER 1 ALF0 1 BET0 1 KINT 0 AHGF 0 CL 0.5
          CQ 2.56 PMIN 0 NUM 1 PREF 1.E5
          LECT flui TERM
     VM23 RO 7800. YOUNG 1.6E11 NU 0.333 ELAS 1.05E8
          TRAC 2 1.05E8 .656256E-3 1.6105E10 1.00066
          LECT stru TERM
LINK COUP
     BLOQ 1 LECT blox TERM
     BLOQ 2 LECT bloy TERM
     BLOQ 12 LECT p126s TERM
     FLSR STRU LECT stru TERM
          FLUI LECT flui TERM
          R 0.0884 ! so that d = 2r = 0.1768
          HGRI 1.6
          DGRI
         !BFLU 0 FSCP 1
          BFLU 0 FSCP 0
INIT VITE 1  -80.0 LECT p122s TERM
          1  -60.0 LECT p123s TERM
          1  -40.0 LECT p124s TERM
          1  -20.0 LECT p125s TERM
          1   20.0 LECT p127s TERM
          1   40.0 LECT p128s TERM
          1   60.0 LECT p129s TERM
          1   80.0 LECT p130s TERM
          2   80.0 LECT p131s TERM
          2   60.0 LECT p132s TERM
          2   40.0 LECT p133s TERM
          2   20.0 LECT p134s TERM
          2  -20.0 LECT p135s TERM
          2  -40.0 LECT p136s TERM
          2  -60.0 LECT p137s TERM
          2  -80.0 LECT p138s TERM
ECRI DEPL VITE ACCE FINT FEXT TFRE 10.E-3
          POIN LECT stru TERM
          ELEM LECT stru TERM
     FICH ALIC FREQ 1 !TFRE 1.E-3
OPTI NOTE
 CSTA 0.5 LOG 1 !dpma
 LNKS STAT
CALCUL TINI 0. TEND 100.D-3
*=================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
!        Q      1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
```

```
        UP    0.00000E+00  1.00000E+00  0.00000E+00
        FOV   2.48819E+01
SCEN OBJE SELV FLSR
     GEOM NAVI FREE
     FACE HFRO
     FLSR DOMA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 963 FPS 15 KFRE 10 COMP -1 REND
FREQ 1 !FREQ 0 TFRE 1.E-3
GOTR LOOP 961 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*==================================================================
SUIT
Post-treatment
ECHO
RESU ALIC GARD PSCR
SORT GRAP
AXTE 1.0 'Time [s]'
COUR 1 'dx_130' DEPL COMP 1 NOEU LECT p130s TERM
COUR 2 'vx_130' VITE COMP 1 NOEU LECT p130s TERM
TRAC 1 AXES 1.0 'DISPL. [M]'
TRAC 2 AXES 1.0 'VELOC. [M/S]'
LIST 1 AXES 1.0 'DISPL. [M]'
LIST 2 AXES 1.0 'VELOC. [M/S]'
*==================================================================
FIN
```

mill14compare.epx

```
MILL14COMPARE
ECHO
RESU ALIC 'mill14.ali' GARD PSCR
SORT GRAP
AXTE 1.0 'Time [s]'
RCOU 11 'dx_130' FICH 'mill11.pun' RENA 'dx_130_11'
RCOU 12 'vx_130' FICH 'mill11.pun' RENA 'vx_130_11'
RCOU 21 'dx_130' FICH 'mill12.pun' RENA 'dx_130_12'
RCOU 22 'vx_130' FICH 'mill12.pun' RENA 'vx_130_12'
RCOU 31 'dx_130' FICH 'mill13.pun' RENA 'dx_130_13'
RCOU 32 'vx_130' FICH 'mill13.pun' RENA 'vx_130_13'
RCOU 41 'dx_130' FICH 'mill14.pun' RENA 'dx_130_14'
RCOU 42 'vx_130' FICH 'mill14.pun' RENA 'vx_130_14'
RCOU 121 'dx_130' FICH 'mill02.pun' RENA 'dx_130_02'
RCOU 122 'vx_130' FICH 'mill02.pun' RENA 'vx_130_02'
RCOU 141 'dx_130' FICH 'mill04.pun' RENA 'dx_130_04'
RCOU 142 'vx_130' FICH 'mill04.pun' RENA 'vx_130_04'
TRAC 11 21 31 41 AXES 1.0 'DISPL. [M]'
COLO NOIR BLEU TURQ VERT
TRAC 12 22 32 42 AXES 1.0 'VELOC. [M/S]'
COLO NOIR BLEU TURQ VERT
TRAC 11 21 31 41 121 AXES 1.0 'DISPL. [M]'
COLO NOIR BLEU TURQ VERT ROSE
TRAC 12 22 32 42 122 AXES 1.0 'VELOC. [M/S]'
COLO NOIR BLEU TURQ VERT ROSE
TRAC 41 141 AXES 1.0 'DISPL. [M]'
COLO VERT ROUG
TRAC 42 142 AXES 1.0 'VELOC. [M/S]'
COLO VERT ROUG
*==================================================================
FIN
```

mill14p.epx

```
MILL14P
ECHO
RESU ALIC 'mill14.ali' GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
*==================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
SCEN GEOM NAVI FREE
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 0.8E5 PAS 0.02E5 1.06E5 TERM
          SUPP LECT flui TERM
     TEXT ISCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 963 FPS 15 KFRE 10 COMP -1 REND
FREQ 1
GOTR LOOP 961 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*==================================================================
FIN
```

mill14v.epx

```
MILL14V
ECHO
RESU ALIC 'mill14.ali' GARD PSCR
OPTI PRIN
SORT VISU NSTO 1
*==================================================================
PLAY
CAME   1 EYE   5.00000E+00  5.00000E+00  3.53995E+01
!        Q     1.00000E+00  0.00000E+00  0.00000E+00  0.00000E+00
         VIEW  0.00000E+00  0.00000E+00 -1.00000E+00
         RIGH  1.00000E+00  0.00000E+00  0.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
SCEN GEOM NAVI FREE
     FACE HFRO
     LINE HEOU SFRE
     VECT SCCO FIEL VITE SCAL USER PROG 10 PAS 10 140 TERM
     TEXT VSCA
     COLO PAPE
SLER CAM1 1 NFRA 1
TRAC OFFS FICH AVI NOCL NFTO 963 FPS 15 KFRE 10 COMP -1 REND
FREQ 1
GOTR LOOP 961 OFFS FICH AVI CONT NOCL REND
GO
TRAC OFFS FICH AVI CONT REND
ENDPLAY
*==================================================================
FIN
```

List of input files

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Abstract

The present work concerns a new aspect of mesh adaptivity, i.e. the automatic refinement of the fluid mesh near a structure, in order to enhance the treatment of Fluid-Structure Interaction (FSI). This technique is particularly useful in conjunction with FSI algorithms of the embedded or immersed type, such as the FLSR or FLSW algorithms available in the EUROPLEXUS code for fast transient dynamics.

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